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Technology Department

ON THE COVER

OUR cover picture gives an idea of the concentration of mechanized mobile equipment on large modern excavating operations. It shows the opening of the mass attack to shear off the summit of Mount Ettrick in New York State in building the airport described in the article beginning on Page 234. The job entails the movement of more than 2½ million cubic yards of earth and rock. The irregular line at the upper right, partly in shadow, is the working face where the rocky crest of the eminence is being drilled, blasted, and loaded by power shovels. Elsewhere, the mantle of overburden is being scooped up by huge self-loading scrapers and other machines. Their tracks make an interesting but jumbled pattern. All spoil is transported to low-lying areas, and the haulage entails thousands of miles of travel.

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IN THIS ISSUE

THE GROWTH in air travel has boosted airport building into a place of prominence in the construction field. The equipment and techniques used are similar to those of the roadbuilder, the main difference being that the former work is more localized. Our leading article describes the construction of the Broome County (N. Y.) Airport which will provide three small but important industrial cities with aerial-transport ground facilities of the latest type.

•

THE Calyx core drill is growing in stature as an engineering and construction tool. As its field of application broadens, new uses are being found for large-size outfits. Numerous units that cut 48-inch cores are now in service, and there are indications that 6-, 8-, and even 10-foot cored holes will be fairly common in the near future. An article starting on Page 238 contains a roundup of information on the status of this adaptable piece of equipment.

•

FOUR years ago we described a huge project designed to lower the water in Steep Rock Lake, Canada, to expose iron deposits lying beneath its bed. The effort was successful and large-scale mining is now in progress, as outlined in this issue. Page 244.

•

AN IMPROVED type of bear-trap spillway gate that is made buoyant by compressed air is a feature of Possum Kingdom Dam in Texas. The designer describes it in an article (Page 247) that also includes a historical sketch of disappearing spillway gates.

•

SHERMAN HILL ballast has long been familiar to railroadmen of the West. Material from this high point in the Union Pacific system has been transported hundreds of miles and by the thousands of tons. Its production now constitutes a huge quarrying operation that is described in an article beginning on Page 250.

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ANNA M. HOFFMANN, *Associate Editor* J. J. KATARBA, *Advertising Mgr.*
A. W. LOOMIS, *Assistant Editor* JOSEPH C. DILTS, *Advertising Sales*
WALTER P. GILLINGHAM, *Assistant Editor*
D. Y. MARSHALL, *Europe* 243 Upper Thames St., London E.C.4.
F. A. McLEAN, *Canada*, New Birks Building, Montreal, Quebec.

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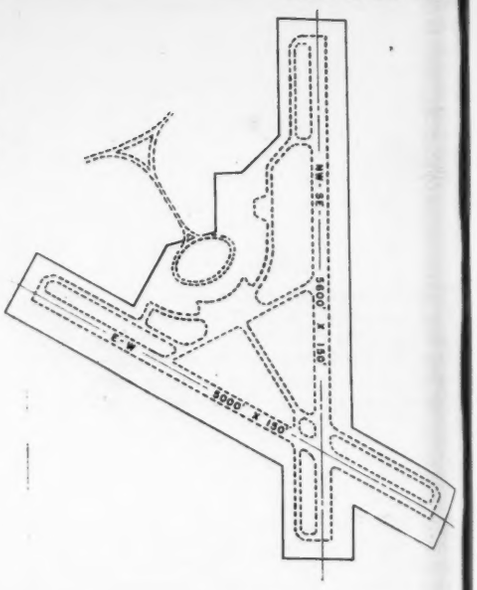
Carving an Airport from a Mountain Top

W. P. Gillingham

PHOTO BY BOB GARVIN



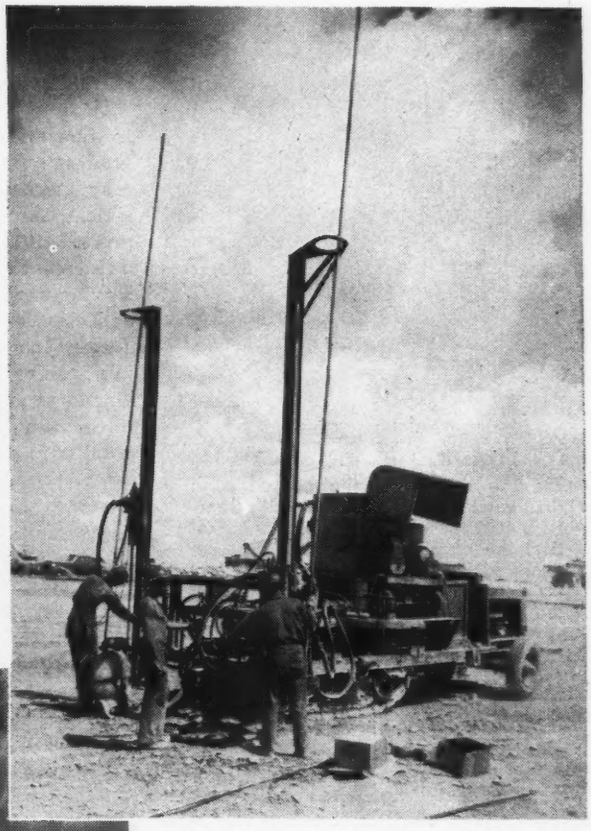
GENERAL VIEWS AND PLAN

The two main runways of Broome County Airport are clearly defined in the aerial view at the top-center. The large mound nearly in the middle of the horizontal runway is the crest of Mount Ettrick. As pictured directly above, it is being removed in a series of horizontal slices or benches. At the right is a plan of the airport. The solid lines enclose the area that is being graded to the level established for the field, while the dotted lines indicate the sections that are to be paved when grading is completed. The administration building, hangars, and other structures will be erected around the oval driveway, which is designed to handle all vehicular traffic to and from the airport. Not shown in the drawing is a shorter turf runway that will connect the two main runways at a point approximately midway.

AIRPLANE pilots usually try to avoid mountains while in flight, but over Broome County, N. Y., they may soon be seeking one with the avowed intention of landing on it. The object of their search will be Mount Ettrick—a 1670-foot-high formation near the neighboring cities of Binghamton, Endicott, and Johnson City. Construction of a multimillion-dollar airport on the mountain is being carried out by Broome County and the Civil Aeronautics Authority, cosponsors of the project, and the contractor's crews have been engaged for several months in knocking off the top of the elevation. Of particular interest in their operations is the novel method employed for drilling blast holes in a ledge of rock encountered in the excavation work.

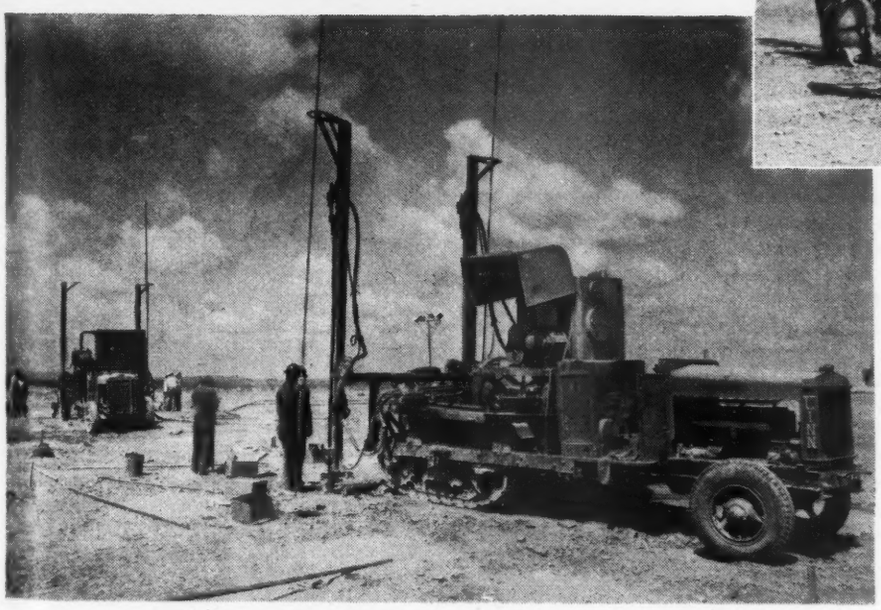
Broome County has a population of some 166,000 persons, of whom approximately 114,000 live in the three cities just mentioned. Binghamton, with a population of 78,000, is the county seat. It is on the Susquehanna River and is an important railroad and industrial center. Nearby Endicott and Johnson City have a combined population of 36,000 and are the homes of such manufacturing concerns as International Business Machines Corporation, Endicott-Johnson Corporation, and others. All told, some 40,000 persons in the Tri-City area are employed in industrial plants, and other thousands are engaged in farming and other activities.

The industrial importance of the Tri-City section, its large population, and the number of travelers who visit the communities each year have emphasized the need for adequate air service. The only airport now operating in the immediate vicinity is at Endicott. Although sufficient as to size, it is unsuited for use by major airlines because of fre-



DRILLING OPERATIONS

The lowermost picture shows two of the three drill carriages improvised by the contractor for putting down blast holes in the rocky crest of Mount Ettrick. Mounted on the mid-section of the near truck is a suction device for collecting dust created by the drilling operations. The drillers in the view directly below are preparing to remove 24-foot lengths of steel from the drills and to substitute for them the 30-foot lengths that are seen extending up through the retaining collars. This simple attachment on a drill tower makes it unnecessary to lay each piece of steel full length on the ground after use and to pick it up again when it is needed.

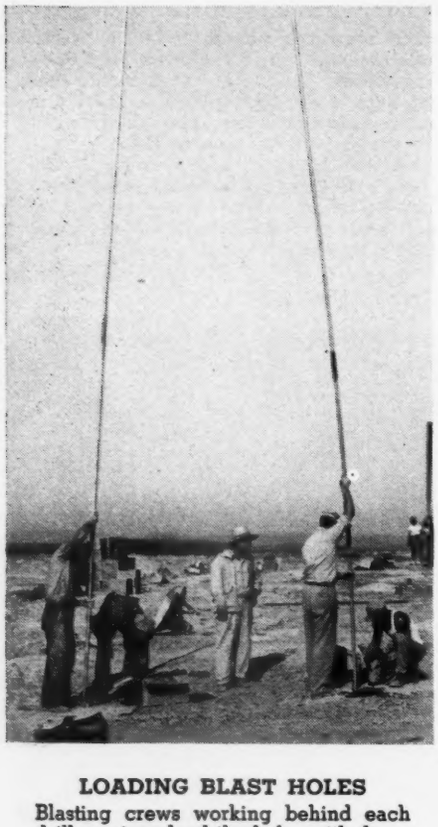


quent river and valley fogs and also because of hills and other obstructions that present hazards to large planes landing on or taking off from the field.

Recognizing that the lack of an adequate airport was unfavorable to the continued growth of the region, Broome County officials took steps to construct an all-weather flying field in an area free of such obstructions as high-tension wires, buildings, church spires, etc., yet close enough to the three cities to serve all the residents conveniently. An 850-acre site atop Mount Ettrick was selected as the one among the available locations that best meets these requirements. The mountain is approximately nine miles from Binghamton and eight miles from Endicott. The site is well above the fog line and is practically free of obstructions that might constitute hazards to flying aircraft.

After preliminary plans for the proposed airfield had been drawn up, application was made to the Civil Aeronautics Authority for Federal funds to aid in its construction. The CAA, with a backlog of 210 million dollars in requests for airport allocations, received a Congressional appropriation of 40 million dollars for the current year starting July 1. Of these funds, $35,098,459 has been earmarked for a $73,819,455 airport-development program which will benefit 455 communities scattered throughout the 48 states and the territories, the CAA meeting approximately half the cost of each project and the remainder being provided by local sponsors. Recipients of the funds are selected according to a formula based on area and population. The Mount Ettrick Project was granted top priority by the CAA, being considered of immediate aeronautical importance.

The field will have three runways: two main ones and a secondary strip, all 150



LOADING BLAST HOLES

Blasting crews working behind each drill carriage load the holes with dynamite. At the close of the day's activities, the charges are fired simultaneously to remove a mass of rock approximately 30 feet wide and extending the full length of the ledge.

feet wide. The longest of the first two will run northwest-southeast for 5600 feet. Its companion, 5000 feet long, will run east and west. The secondary runway, 2300 feet long, will extend northeast-southwestward, connecting the two longer ones about at their midsections, and will be used by light planes. The total cost of the project, including grading and paving of the two main runways, grading and turfing of the secondary strip, and providing the necessary buildings, hangars, parking strips, etc., is estimated at around $4,000,000. The CAA is matching the county's appropriations on all the items except that of land acquisition, towards which the county pays 75 percent and the CAA 25 percent.

Before actual construction was begun, some 28 separate studies of the site were made to determine the final location of the runways and the grade to which the surface was to be leveled. The location selected was such that the crest of Mount Ettrick lay near the center of the line for the 5600-foot runway. The surrounding area sloped gently downward in all directions from the apex of the mountain except for two knolls, one at the western end of each of the two main runways. The elevation of the field was established at a level 62 feet below the highest point, and all material lying above this plane was to be removed and transported to fill areas to bring them up to grade. The grade line was chosen so that cut and fill quantities would approximately balance.

Bids were then asked for the clearing, grading, and drainage of the site, a task that called for the excavation of 2,600,000 cubic yards of earth and rock. D. W. Winkelman Company of Syracuse won the contract on a low bid of $1,968,627, which was $233,085 under the estimated cost. The contract was signed on May 1 and shortly afterward a crew of 175 men, equipped with 55 power units, began to level off the top of the mountain.

Although May 1, 1949, is the date set in the contract for the completion of the grading operations, the advent of winter may, perhaps, make that work impossible. Accordingly, grading is being pushed at a rate that is calculated to finish the major part of it by October 31, leaving the remainder such as trimming and cleaning up until spring. Included among the present power units on the job are five 2½-cubic-yard shovels, one loader, ten end-dump and eighteen bottom-dump trucks, six scrapers, twelve bulldozers, four sheep's-foot rollers, two 3-wheel rollers, three motor graders, one grease truck, and one fuel truck. The power units are operated two 10-hour shifts a day, illumination for the night shift being furnished by portable generators. Fuel and grease trucks operate 24 hours a day to keep the earth-moving machines on the go. Altogether, the various pieces of equipment are moving some 23,000 cubic yards of earth and rock a day.

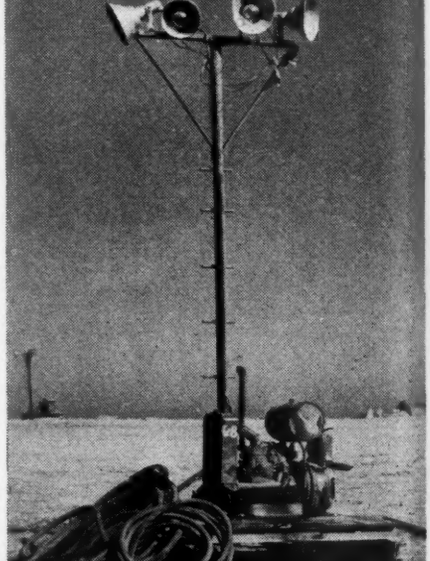
Removal of the two smaller knolls presented little difficulty, but the crest of Mount Ettrick was not so easily taken off. Underneath some fifteen feet of overburden was a ledge of rock of which approximately 800,000 cubic yards was above grade and had to be excavated. The rock is a shale of medium hardness and of uniform composition. Ordinarily, its excavation would call for conventional methods of drilling and blasting, using wagon drills to put down the blast holes. However, the uniform composition of the shale and the shape and flat-lying nature of the formation permitted the adoption of a rather unusual method of drilling.

Three Linn halftracks—trucks with pneumatic-tired wheels in front and crawler treads in the rear—are used as movable drill carriages. On the back end of each of them is a horizontal bar mounted about 5 feet above the ground. It is held in position by vertical I-beam columns welded to it and bolted to the truck bed and is braced by sections of angle iron secured in a similar manner. Two Ingersoll-Rand Type DBM-3 drill mounts are fastened to the outer ends of the bar for use in drilling vertical holes. In addition to this bar, one truck is also equipped with a second and lower bar for use in drilling horizontal holes in the vertical sides of cuts made in the shale bed.

The DBM-3 is a drilling and broaching mount carrying an X-71 drifter drill and having a normal length of feed sufficient to permit making 9-foot steel changes. For this particular job, however, the towers of four of the drill mounts were lengthened so as to provide for 12-foot steel changes. Three lengths of steel are being used for most of the drilling: a 12-foot, a 24-foot, and a 30-foot length. A cup-shaped holder mounted on a brace near the bottom of each drill tower and a retaining collar on the top enable the sections of drill steel to be handled and used with a minimum of effort and to be moved along with the truck as it advances.

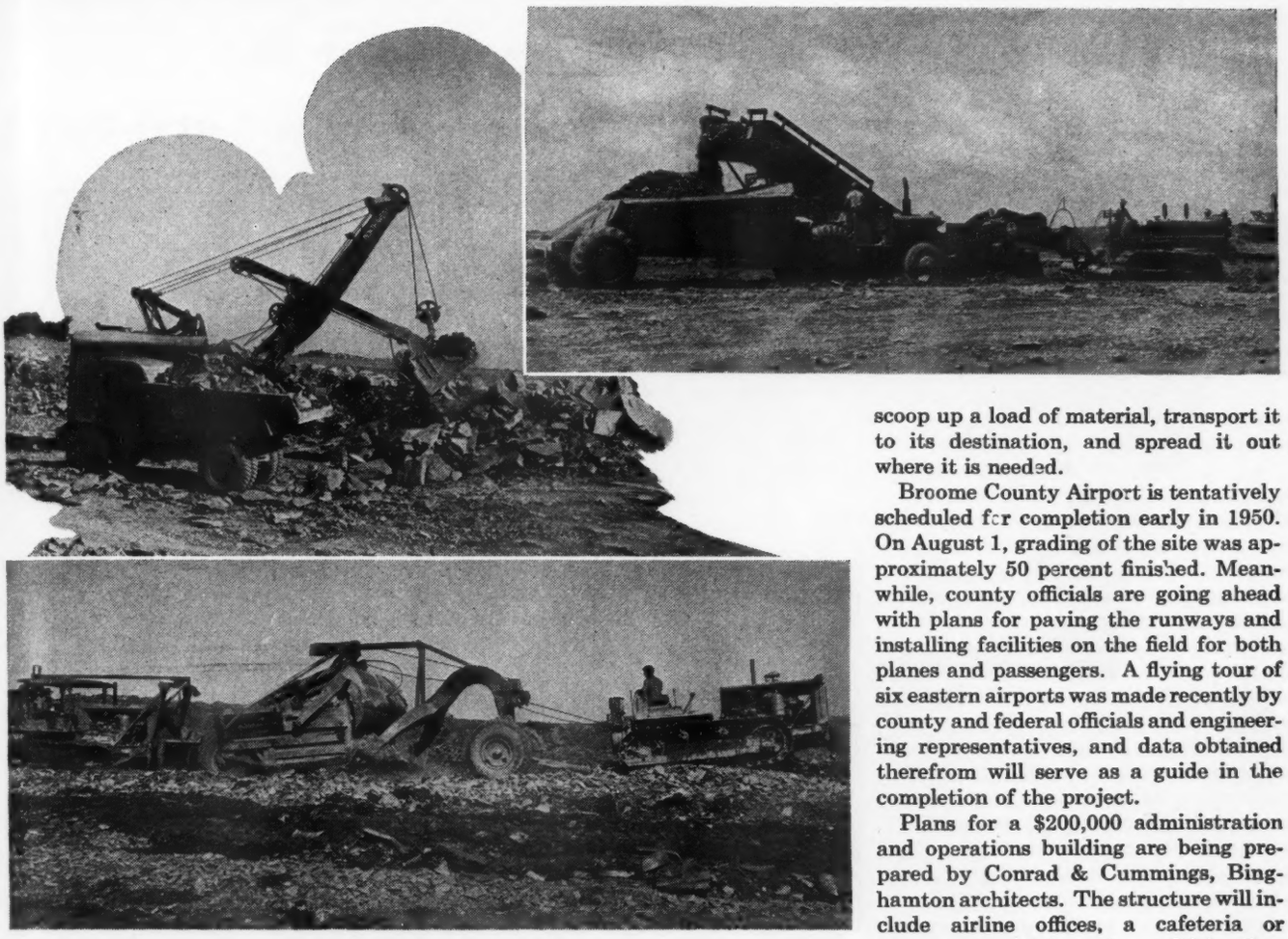
Compressed air is supplied to the drilling units by five portable compressors having a combined capacity of 1470 cfm. at a pressure of 105 psi. They discharge into a common receiver, from which two pipe lines extend to the area being drilled. From the ends of the lines, air is supplied to the drill carriages by hoses that are long enough to permit each rig to operate within a fairly large radius. From time to time, the compressors, receiver, and delivery lines are moved to keep up with the advancing drills. The air pressure at the drills is 90 psi. and more.

The locations of the drill holes are



PORTABLE LIGHTING UNIT

Grading operations do not cease with the coming of night. Twenty of these skid-mounted, self-contained lighting units provide the illumination needed to keep the earth-moving equipment rolling from dusk till dawn.



MOVING EARTH AND ROCK

A considerable number of heavy earth-moving units is being used in the grading operations. Rock broken by the previous day's blast is loaded into trucks by power shovels. At the upper left is shown a Northwest shovel about to dump a 2½-cubic-yard dipperful of broken material into a waiting Euclid truck. In the lower view, a bulldozer gives a friendly push to a tractor-drawn Le Tourneau Carryall scraper that is scooping up a load of earth and rock for removal to a fill area. Overburden and other unconsolidated material are handled by a Euclid loader (upper-right). This tractor-pulled device loads continually into bottom-dump trucks that come up alongside one after another.

staked out in advance of the drilling operations. Holes are spaced on 12-foot centers and in most cases are drilled to a depth of from 25 to 28 feet. The two drilling units travel along the line of stakes in tandem fashion, drilling at alternate locations. A truck is first maneuvered until its drills are in proper alignment with the stake at that particular spot. Drillers next loosen the vertical swing bolt of each drill tower and adjust the latter until it is vertical. Bolts are then tightened and drilling begun, using 12-foot lengths of drill steel. When each steel has drilled to its full length, it is withdrawn from the hole, lifted up through the collar and its bit end set in the holder, and the next-longer piece of steel is removed from the holder and dropped into the hole. When the two holes have reached the proper depth, the truck is advanced to its next position and the procedure is repeated. With these drill carriages, drillers have been able to average 80 feet of hole an hour with each drill. Size 2⅜-inch Jackbits are used, each bit drilling roughly 40 feet of hole before becoming dull, when it is shipped with others to Syracuse for resharpening.

As soon as a drill rig has completed its two holes at a given location and been moved ahead to a new one, the blasting crew loads the holes in preparation for firing. Dynamite of 30 and 40 percent strength is used. The holes are filled solidly to within 6 feet of the top, long wooden poles being used to tamp the explosive firmly in place. The remainder of the hole is then filled with stemming. Blasting is done at the end of each day's drilling activities, using electric detonators for firing. The material thus broken is loaded by power shovels into trucks and transported to areas of fill, where it is compacted by rollers and by the passage of heavy vehicles over it. Some of the broken rock is removed by scrapers that scoop up a load of material, transport it to its destination, and spread it out where it is needed.

Broome County Airport is tentatively scheduled for completion early in 1950. On August 1, grading of the site was approximately 50 percent finished. Meanwhile, county officials are going ahead with plans for paving the runways and installing facilities on the field for both planes and passengers. A flying tour of six eastern airports was made recently by county and federal officials and engineering representatives, and data obtained therefrom will serve as a guide in the completion of the project.

Plans for a $200,000 administration and operations building are being prepared by Conrad & Cummings, Binghamton architects. The structure will include airline offices, a cafeteria or restaurant, postal service, a CAA office, an express and air-freight office, a weather bureau, and luggage and rest rooms. A deck or promenade may be erected from which travelers and others could watch planes landing and taking off. County officials are also considering a plan to develop a park and recreational area for use by visitors who like to watch but don't fly themselves.

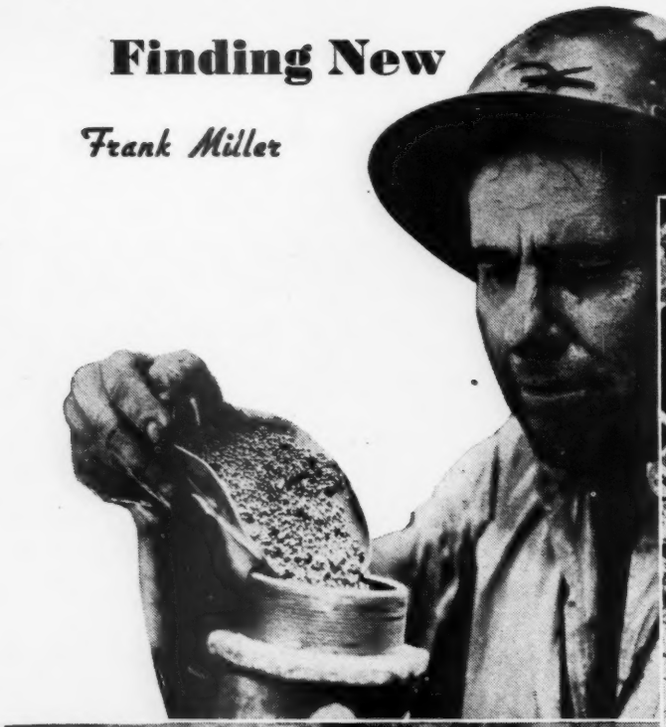
Completion of Broome County Airport will give the Tri-City area air-transport service surpassing that of all other cities of the state except New York. Transcontinental & Western Air Lines, Colonial Air Lines, and American Air Lines are the three major air carriers that have been granted permission to serve the field, while Robinson Air Lines will provide regional transportation.

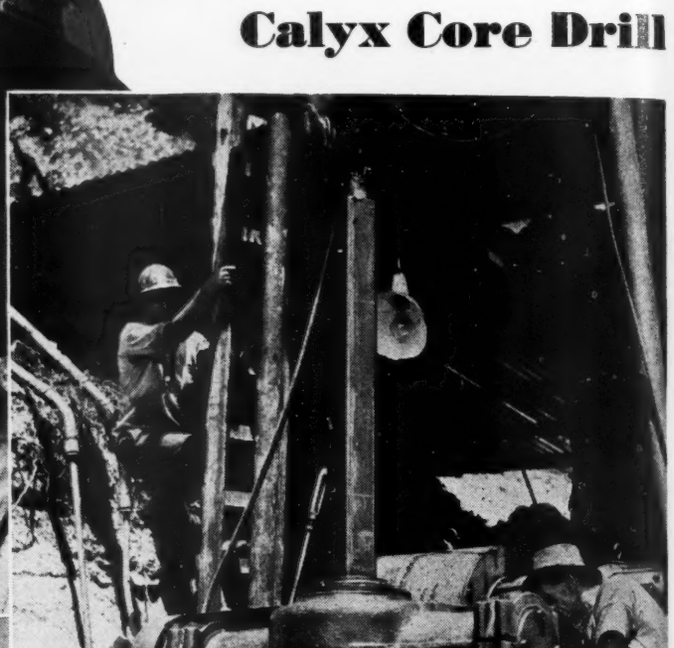
Appreciating that an airport is no better than the roads leading to it, the Broome County authorities are planning to make the field the focal point of three traffic arteries. The highway program will involve a cost estimated at $500,000 and will require several years for completion. It is to start at once with the improvement of one primary road.

J. M. Nicolson is general superintendent for D. W. Winkelman Company on the Mount Ettrick Project. S. P. Carman, representing Seelye, Stevenson, & Value of New York City, is consulting engineer for Broome County.

Finding New Uses for the Calyx Core Drill

Frank Miller





EXPLORING DAM FOUNDATIONS

Calyx core drills are used extensively for testing rock formations underlying dam sites for strength, soundness, and general suitability as a foundation material. At the Warragamba Dam site on the Nepean River, New South Wales, a total of 2570 feet of 48-inch-diameter holes was sunk in exploring the sandstone foundation rock. When completed, the dam will be a 340-foot-high gravity structure capable of impounding 450 million gallons of water. Shown above is one of the drills used there. The 5½-inch square spindle that turns the rods and bit can be seen extending through the driving head. Pictured at the upper left is a workman pouring chilled steel shot into the wash water flowing to the rotating bit. At the left is a view down one of the holes. The three arms extending from the drill rod to the side walls keep the rod centered in the hole. These centralizers are spaced at intervals of about 40 feet.

THE Calyx core drill, sometimes called shot drill, occupies a unique position in the rock-drilling field. It is used for boring large-diameter holes, work in which no other rotary tool can match it in first cost, performance, and economy of operation. Since its introduction into this country from Australia about half a century ago it has become standard equipment for special jobs in construction, mining, quarrying, and similar operations. In recent years, however, the scope of the Calyx drill has been broadened, and these new applications, together with improvements that make it possible to drill large-diameter holes of great depth, have widened the equipment's field of usefulness.

The most common form of Calyx drill is the drill-rod type in which the bit is rotated by a hollow rod driven by a motor and gearing located on the surface. The bit, made of mild steel rolled into cylindrical form, has several inclined slots cut in the lower edge. Chilled steel shot is fed into the hollow drill rod along with water and carried by the latter down the inside surfaces of the bit, through the slots, and under the cutting edge. There the shot is crushed by the weight of the bit. The particles become embedded in its soft metal edge and wear away the rock beneath by abrasive action as the bit rotates at speeds varying with its diameter. After passing through the slots, the circulating water rises on the outside of the bit, carrying the rock cuttings with it to the top of the bit where, because of a decrease in the velocity of the flow, they fall into a sludge receiver. Only enough water pressure is used to remove the cuttings without disturbing the heavier shot.

The Calyx drill is primarily a rock drill and as such is not intended for cut-

ting through overburden or formations which are softer than the bit itself. The abrasive action of the bit is impaired if the steel shot is not crushed between it and the material penetrated. Cutting speed therefore depends upon the type of rock drilled. With a 48-inch-diameter bit it is possible to cut limestone, for example, at the rate of 15-18 inches an hour; granite at 10-12 inches an hour. For any given rotational bit speed, the drilling speed in a particular material depends upon the rate at which shot is fed to the bit and upon the pressure exerted on the rock by the cutting edge.

When the bit has penetrated to a depth equal to its height, the core must be removed from the bit before further drilling can be done. Cores ranging up to 20 inches in diameter are released by introducing small pieces of gravel about the size of peas or beans into the wash water flowing to the rotating bit. These become wedged between the bit and the core, breaking off the latter and holding it securely so that it can be raised to the surface with the bit.

Cores that are 36 inches in diameter and larger are removed by an entirely different method and, if of solid rock, may be brought to the surface in one piece. The bit is first lifted out of the hole by means of the hoist with which each Calyx drill is equipped, and the excess water is withdrawn by a baler or by an air-driven sump pump. Next, a man is lowered into the shaft to drill a hole in the center of the core for the insertion of a split pin with an attached ring to which a cable is fastened. The core is then broken off at its base either by driving wedges along one side or by exploding a small charge of dynamite and, that accomplished, is raised by the hoist.

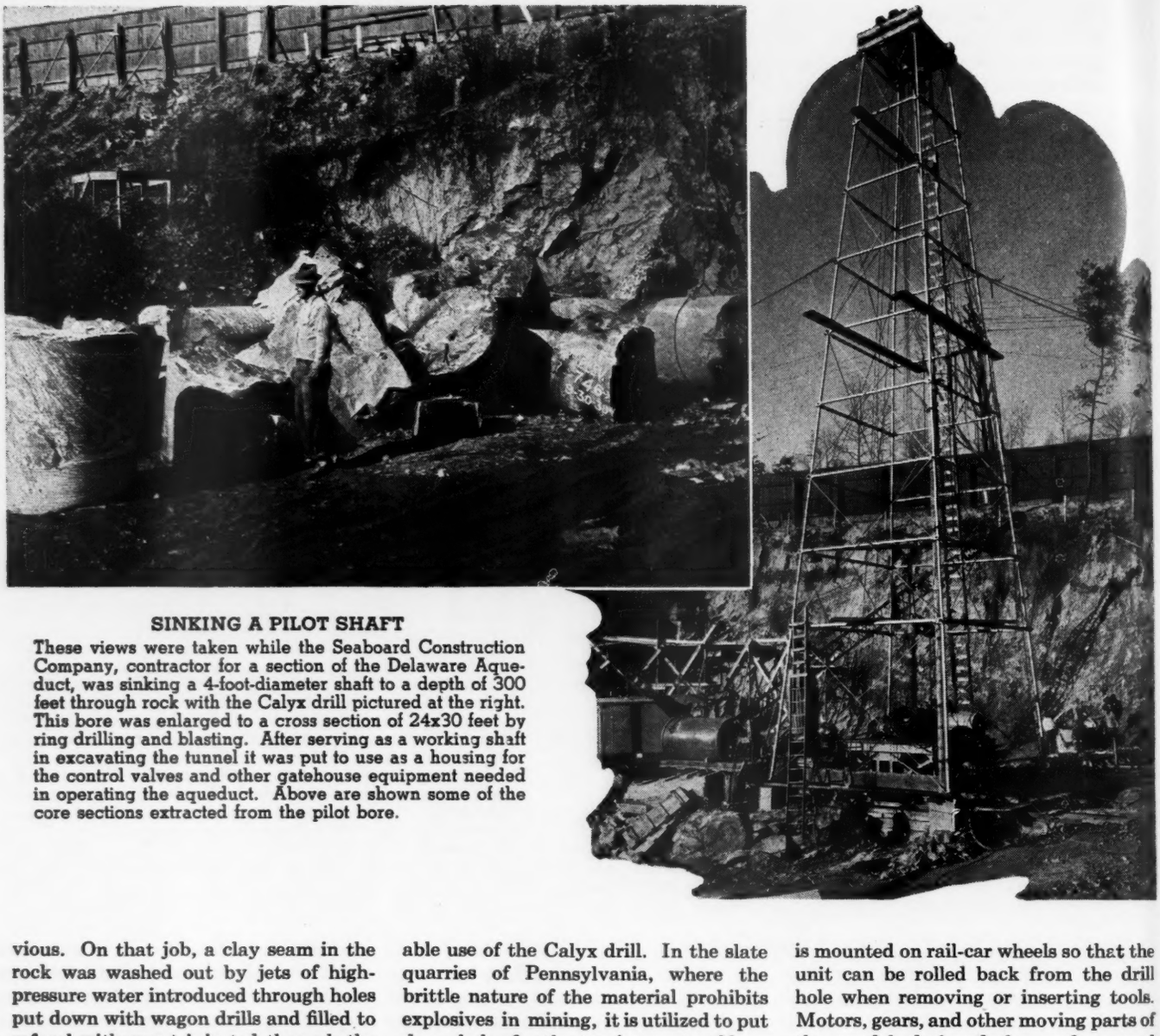
The work of extraction may also be done by a core lifter, a cylindrical device that slips over the core and grips it firmly so that it can be raised. If a core is broken, the main pieces are removed separately by cable slings and the bottom is mucked by hand into a bucket before the bit is again lowered and drilling resumed. A steel derrick is usually erected over the opening to facilitate handling the bit, drill rods, core lifter, baler, and other equipment.

Calyx drills of the drill-rod type are designed to cut holes up to 48 inches in diameter to depths of 400-500 feet. They have been widely used for this purpose in the building of dams, where the weight of the massive structures and the immense sums of money involved necessitate taking every precaution to insure a firm foundation. Prior to the construction of Norris Dam, one of many erected by the Tennessee Valley Authority, knowledge of subsurface geologic formations was generally obtained by means of small coring drills. These, however, sometimes give unreliable information in the case of ground containing soft spots or other weaknesses because the small cores often disintegrate. Therefore, engineers at Norris Dam decided on a new method of underground exploration that called for the cutting of 36-inch-diameter holes with a Calyx core drill and lowering a man into the holes to study the formations in place. The initial results were so satisfactory that the procedure was adopted for Grand Coulee, Fort Peck, Bonneville, Shasta, Friant, and other western dams and is now standard procedure for structures of that type built under the supervision of the U. S. Bureau of Reclamation and the U. S. Army Engineers.

Also at Norris Dam, the Calyx drill served to check on the effectiveness of grouting that was injected into underlying formations to make them imper-

VENTILATING MINE WORKINGS

Pictured below, left, is a 36-inch Calyx core drill being used to sink a ventilating shaft between levels in a large underground mine. The frame carrying the driving head, motor, etc., has been moved back from the opening to permit a man to enter the hole in a bucket to remove bits of broken core. At the right the bit is shown as it is about to be lowered into the hole to resume drilling. A section of the core removed from the hole is seen at the bottom-right.



SINKING A PILOT SHAFT

These views were taken while the Seaboard Construction Company, contractor for a section of the Delaware Aqueduct, was sinking a 4-foot-diameter shaft to a depth of 300 feet through rock with the Calyx drill pictured at the right. This bore was enlarged to a cross section of 24x30 feet by ring drilling and blasting. After serving as a working shaft in excavating the tunnel it was put to use as a housing for the control valves and other gatehouse equipment needed in operating the aqueduct. Above are shown some of the core sections extracted from the pilot bore.

vious. On that job, a clay seam in the rock was washed out by jets of high-pressure water introduced through holes put down with wagon drills and filled to refusal with grout injected through the same openings. Next, more than 500 Calyx holes 5½ inches in diameter were drilled on 20-foot centers and a periscopic device used to peer into them to examine the grouting. Grouting was done through closely spaced holes of the same kind at other dams to stop leakage.

Calyx drills have been used extensively in foundation work for large buildings. In addition to cutting holes for the purpose of determining the character of the subsurface, they have played a part in the actual excavating. Many of New York City's skyscrapers rest on concrete piles that consist of sections of steel casing driven into soft ground and filled with concrete. Sometimes it was necessary to bore through large boulders that lay in the path of a pipe, and this work was done by Calyx drills. They have also served to cut shafts for the installation of elevator plungers, and the stage in Radio City in New York is raised and lowered by plungers traveling in Calyx boreholes.

Other industries have made considerable use of the Calyx drill. In the slate quarries of Pennsylvania, where the brittle nature of the material prohibits explosives in mining, it is utilized to put down holes for the tension posts of long wire saws that cut the beds of slate into blocks for processing. Because of its smooth cutting action, the drill does not damage the material; in fact, even the core removed from the drill hole is usable slate.

Highway departments of many states mount small Calyx drills on truck or trailer bodies to extract cores from newly completed roads. This is done in order to make sure that specifications have been met in regard to thickness, grade of construction materials, etc. These outfits are also used to raise sunken sections of concrete highways by cutting holes through them and injecting a soil-cement mixture under the slabs until they are restored to their former level, a procedure known as mud-jacking.

One of the more recent applications of the core drill is that of boring holes to serve underground mines as ventilating shafts or ore and waste passes. For operations of this type, the motor, gears, driving head, and hoist are grouped in a compact arrangement on a frame which is mounted on rail-car wheels so that the unit can be rolled back from the drill hole when removing or inserting tools. Motors, gears, and other moving parts of the model designed for underground work are completely enclosed to keep out dust, dirt, etc. Furthermore, it is built so that it can be dismantled and lowered, piece by piece, through the opening it has drilled, thus permitting its transportation below ground in spite of the restricted space.

Ventilation shafts put down by Calyx drills possess many advantages over those driven by conventional means. Because no explosives are used there is no shattering of the surrounding rock. Consequently, timbering is not needed, the walls standing entirely without support. This permits a greater flow of air than through an ordinary timbered shaft of equal cross-sectional area, for rough timbers offer an appreciable resistance to the passage of air. Furthermore, timbers in a ventilation shaft increase the hazard of fire in a mine. The same is true of ore or waste passages bored by the Calyx drill. Their smooth, untimbered walls present no obstacle to the material, so that it will seldom hang up and choke the passageways. In regard to the cost

of such boreholes, a shaft 36-48 inches in diameter can be sunk by a Calyx drill for about the same amount as by conventional methods.

A good example of Calyx holes drilled for ventilating purposes is found in a Montana copper mine. There a unit, powered by a 30-hp. motor, was set up underground to sink shafts during the driving of bottom levels. The ventilation of such workings during the development stage is usually a major problem, for the raises by which a level is connected to the upper workings and by which free passageway for air is provided are normally not driven until the level is completed or at least considerably advanced.

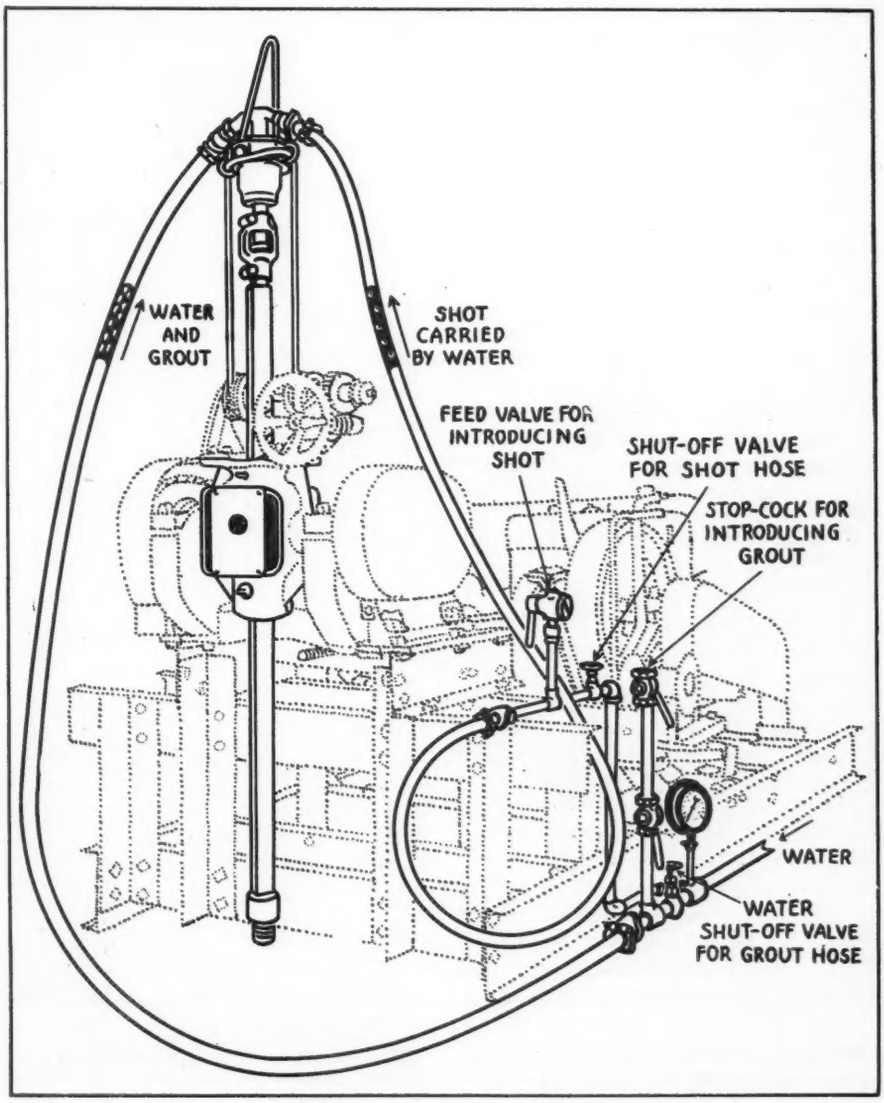
In the Montana mine, however, the difficulty was overcome by sinking 36-inch-diameter holes from an existing level to intersect one to be opened up directly under it, the work being carried out in advance of the actual excavating of the lower level. The first such opening was drilled at a distance of approximately 100 feet from the main shaft. It served as a return-air shaft and obviated the need of partitioning the main shaft into upcast and downcast passages. The second hole was drilled at a point about 1000 feet from the main shaft. When the men driving the bottom level reached this opening it became the return-air shaft by shifting the ventilating fan from the first hole, which was then used to carry pipes, electric cables, and communication lines between the two levels. The 36-inch return-air shaft is equipped to handle 20,000 cfm.

One of Arizona's largest underground copper producers cuts numerous Calyx holes to serve as fill holes for stopes where the outline of the ore body is definitely known. The mine is worked by the inclined cut-and-fill method, and holes 48 inches in diameter are sunk at intervals of 50 feet for filling stopes following cuts. Where irregular ore bodies lie at low angles, their upper extensions are filled by chuting waste through Calyx holes bored to meet the extensions. Another use found for the holes is as passageways or emergency exits, each being equipped for the purpose with steel-runged chain ladders.

A large copper mine in Montana has a system of handling waste that involves drilling 48-inch-diameter Calyx holes parallel to and at a distance of approximately 60 feet from the main shafts. These boreholes connect with stations at each level, and the material may be either drawn off at the stations or by-passed to levels below. The waste is carried to the top of the system by bottom-dump skips and distributed thence throughout the mine. This eliminates costly transfer by cars and is made possible only because of the availability of core drills, as the nature of the country rock does not permit blasting within 100 feet of the shaft. The same mine also uses such holes for ventilating purposes.

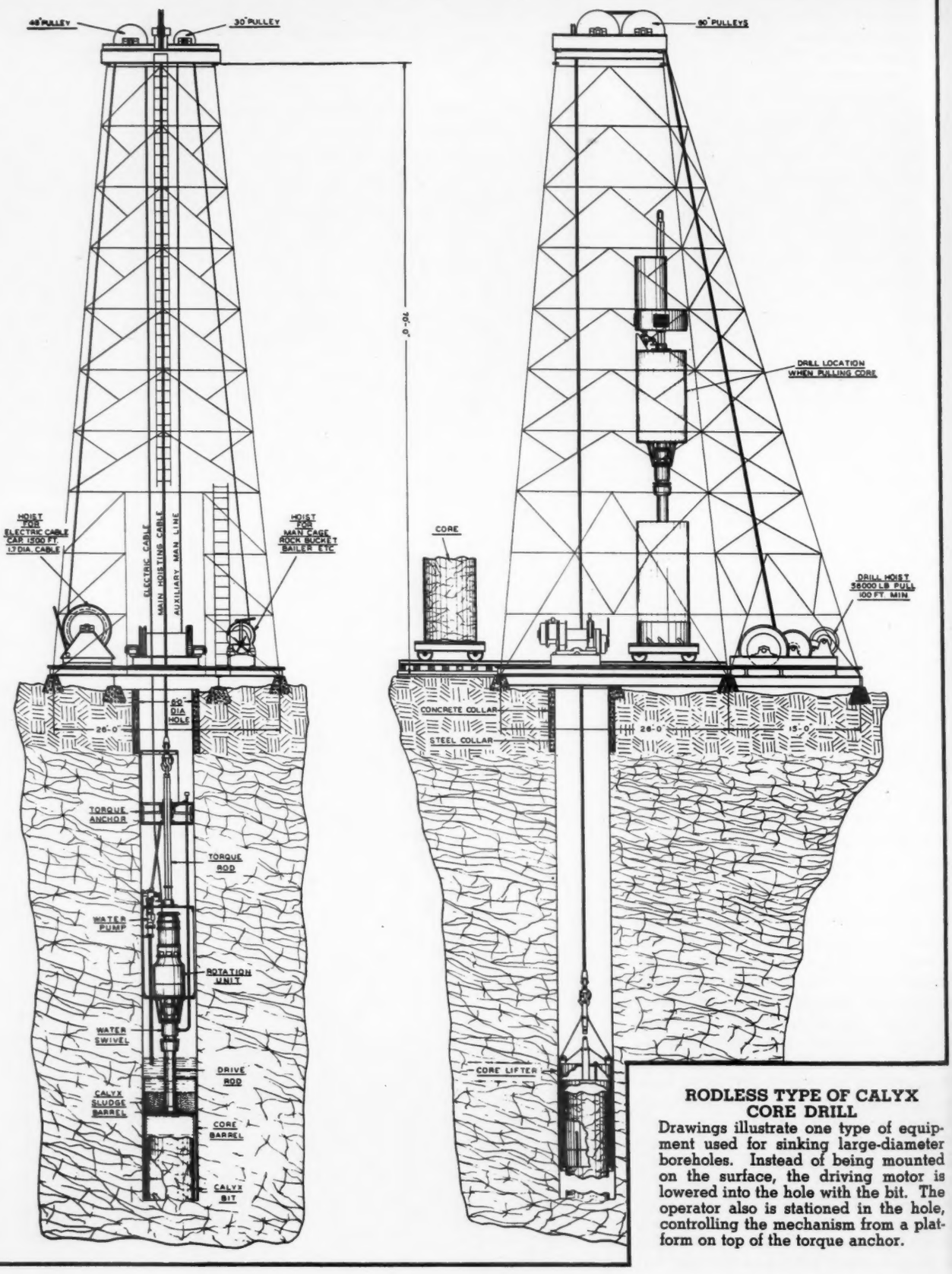
One application of the Calyx drill that seems to have a promising future is that of putting down pilot bores when sinking shafts between levels in a mine or from the surface. One copper producer has practiced this method with good results in deepening an auxiliary shaft. A 48-inch-diameter hole was first drilled from the bottom of the shaft to a level 300 feet below. The opening was then enlarged from the top down, all rounds being blasted into the hole, from which the broken rock was withdrawn by way of a chute dumping into cars on the level beneath. Besides obviating the disposal of muck by hoisting, the pilot bore maintained ventilation in the shaft so that smoke and gases could be quickly exhausted from the working area following shooting. The hole also provided drainage, eliminating the periodical removal of water from the shaft bottom.

In recent years, the number of holes of large diameter sunk from the surface to considerable depths has been on the increase. The mining industry has put down three, the first one on record being a 60-inch-diameter hole 1125 feet deep drilled at the Idaho-Maryland Mine in California for use as a service and ventilating shaft. Two boreholes each 66 inches in diameter were put down by Pickands, Mather & Company on the iron range of Minnesota and Wisconsin. One of them at the Zenith Mine is 1208 feet deep. It was equipped with a fan to serve as a ventilating shaft, handling some 50,000 cfm. of air. Later it was enlarged and converted into a 5-compartment, steel-supported, main hoisting shaft, the work being done by blasting rounds into the opening and pulling the muck from the bottom through a chute. The second hole was sunk at the Cary Mine to a depth of


WATER AND GROUT
SHOT CARRIED BY WATER
FEED VALVE FOR INTRODUCING SHOT
SHUT-OFF VALVE FOR SHOT HOSE
STOP-COCK FOR INTRODUCING GROUT
WATER
WATER SHUT-OFF VALVE FOR GROUT HOSE

METHOD OF FEEDING SHOT AND GROUT

Steel shot, which is crushed to form the cutting abrasive, is introduced into the wash water while the bit is doing its work. After a length of core has been bored, the flow of shot is shut off and grout is introduced to break off the section inside the bit.



RODLESS TYPE OF CALYX CORE DRILL

Drawings illustrate one type of equipment used for sinking large-diameter boreholes. Instead of being mounted on the surface, the driving motor is lowered into the hole with the bit. The operator also is stationed in the hole, controlling the mechanism from a platform on top of the torque anchor.

2587 feet, more than twice that of the other, with the idea of enlarging it into a 13x21-foot hoisting shaft. This was done, the operations being carried out in a manner similar to those at the Zenith.

The equipment that is used to sink the large-diameter boreholes differs considerably from the drill-rod type which, because of the weight of the rods and the power required to turn them, is not economical beyond depths of 400-500 feet. A rig was therefore developed in which the motor is closely coupled to the bit, making a single unit that is lowered into the hole by a cable. The operator does not remain on the surface but descends with the drill. Standing on a platform built atop the motor, he controls the latter, the pressure of the bit on the rock, the flow of wash water,

and the feed of steel shot to the bit. A torque device that expands against the sides of the opening prevents the motor from turning as the bit rotates.

Drills for holes 6 feet and more in diameter are powered by a 100-hp. motor, the motor capacity depending upon the size of the drill. With the rodless type of Calyx, all the power generated by the motor goes into turning the bit—none is needed to rotate drill rods. Therefore, the only thing that limits the depth to which a hole may be drilled is the capacity of the hoisting equipment on the job. Further, when utilized for sinking mine shafts, this type of Calyx makes it possible to effect considerable savings because the installation can be engineered in such a way that the permanent headframe and hoist house for the shaft can be erected first and used to raise and lower the drilling equipment.

In view of the performances of the Calyx drill and the improvements that have been made in equipment, methods, and drilling speed, the author envisions still larger rigs and wider fields of application. For instance, there is every possibility that the shaft of the future may be circular in form. A borehole 10 feet in diameter would be no more difficult to drill than one 6 feet in diameter, because the average cutting speed of the Calyx does not decrease materially with an increase in the size of the bit. Such a shaft, with a spiral staircase to serve as a manway and with a circular or square cage in the center, certainly would seem to have advantages over the conventional shaft. No timbering would be required, as the staircase around the sides would prevent soft spots in the walls from sloughing off and would be much safer than the customary ladder arrangement.

TESTING CONCRETE HIGHWAYS

A Class PT Calyx core drill taking samples from a newly completed roadway section. This unit, mounted on a trailer base, incorporates a 25-gallon tank that supplies the bit with wash water.

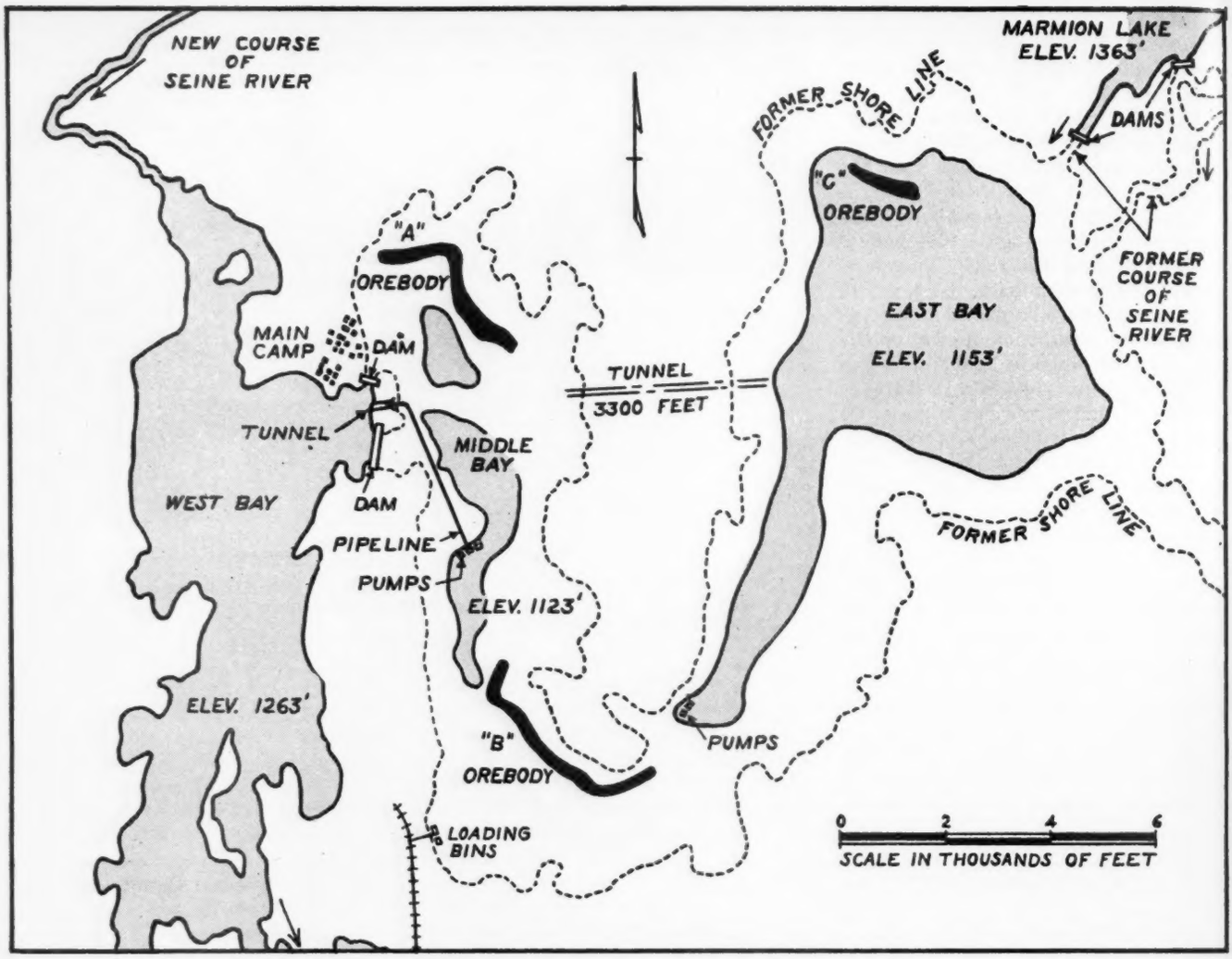
Other ways in which Calyx holes might be useful are in drawing off gases generated by burning thin, unworkable seams of coal *in situ* and in providing better ventilation in collieries. Vertical holes could be bored to draw off any gases that might be trapped in beds ahead of advancing workmen and at the same time establish ventilation as soon as they reached those areas. Another variation of the same idea, which has recently been patented, involves drilling a large hole from an underground level through coal-and-rock formations by first sinking a pilot hole for a rotating shaft and then, by a larger boring tool attached at the lower end of the shaft, drilling upward while disposing of the core on the bottom level.

The Calyx drill may, in future, find wide application in the search for mineral deposits. In addition to revealing information as to the character of the deposits penetrated, the boreholes would serve as ventilating or access shafts during the development and mining stages of the ore bodies. For example, should the extensive oil-shale deposits in our western states be exploited, as they undoubtedly will, the large-scale underground mining operations entailed would call for the use of power shovels, trucks, and other heavy equipment and would necessitate the delivery of large quantities of fresh air through suitably spaced ventilating shafts.

Though some of the potential applications of the Calyx drill may seem visionary to the layman, it is safe to predict that the equipment, because of the continual demand for better and more economical methods of shaft sinking, will play an increasingly bigger part in the rock-drilling field.

STOPPING LEAKAGE UNDER DAM

Water seeping under Hales Bar Dam on the Tennessee River was stopped by the Tennessee Valley Authority in a novel manner. A curtain of concrete was placed in the foundation rock just upstream from the dam by drilling rows of overlapping, 18-inch-diameter Calyx holes and filling them with concrete. Above is a view of six of the drills used in that work.



GENERAL PLAN OF STEEP ROCK DEPOSITS

The water in Middle Bay has been pumped out sufficiently to expose ore body "B" which is now being worked by the open-pit method. The top of "A" ore body is also below water level, but a thick layer of silt must be removed from it before mining can be started. As intermittent borings along the 6000-foot interval that separates "A" and "B" have indicated ore, these deposits may be connected at depth, making an extremely large ore body available. The surface of deposit "C" is still 375 feet underwater. The level of East Bay will be lowered 30 feet by diverting the water through the tunnel shown below the arrow. Several years of dredging would be required to expose ore body "C," but further exploration may prove that work to be economically warranted.

Steep Rock Iron Mine

W. M. Goodwin

AN article in the April, 1943, issue of this publication described the early stages of the Steep Rock iron-ore development in northwestern Ontario, Canada. The finding of hematite boulders there as early as 1897 led to diamond drilling in 1938 that located underneath the bed of Steep Rock Lake three separate sizable ore bodies that are designated as "A," "B," and "C." An attempt to reach one of the deposits by means of a shaft and crosscut failed because of the influx of water, but it provided an opportunity to explore the ore occurrence at depth by drilling. The excavation of a new channel for the Seine River which flowed through the lake was completed at the end of 1943, the water of the lake and the silt on the bottom were pumped out by the spring of 1945 sufficiently to expose the "B" ore body, the highest of the three deposits, and in that year almost one-half million tons of ore was shipped mainly to furnaces in the United States.

Production from the "B" ore body is now established at the rate of a million tons a year, or somewhat better. Output is at present coming from an open pit 2000 feet long, which will be extended by 1000 feet or more. This pit is expected to yield ore at the current rate for some ten years. Before the pit reaches the limit of economy with increasing depth, an underground mine will be developed to yield a like annual tonnage. As the ore stands almost vertically and is proven to a considerable depth, the underground mine will last for many years.

Drilling has shown that "A" deposit is something more than double the size of "B" and that it similarly extends to a great depth. Though the water of the lake has been removed from above it, there remains a very large amount of silt in that part of the lake bottom, which is wide and long. Experience with "B" deposit has shown that the blanket of silt overlying the ore must be completely removed to permit mining the ore effectively.

The removal of this silt, estimated at 45 million cubic yards, will be a major operation. Fortunately it is known that the cost per yard will be extremely low. The fourteen big Ingersoll-Rand pumps that were used to pump out the lake and to remove the silt above "B" are not alone adequate for the job. What is projected is an operation similar to that in the Beauharnois Canal, on the St. Lawrence 30 miles west of Montreal, where a large suction dredge has dug a big power canal through clay at a phenomenally low cost per yard. Plans are being made to employ a somewhat similar dredge to complete the preparation of "A" deposit for open-pit mining. The estimated time of pumping is two years. When in full production, "A" deposit will furnish two million tons and more of ore a year. This will put Steep Rock in the top rank of North American iron mines.

While drilling has been concentrated on the "A" and "B" areas, enough prospecting has been done between them to show that there are at least scattered lenses of ore. From the geological evidence there is nothing to preclude the occurrence of ore continuously between the two, a distance of 6000 feet. With 4000 feet of ore indicated in "A" ore body and the south end open, and 4000 feet in "B" with both ends open, there is a distinct possibility that the whole length of Middle Bay, 2½ miles, may eventually become a single long, open pit. It will take a good deal more drilling to find out just how much of the ground between the two proven ore bodies is ore.

When the dredge has completed its job in Middle Bay there may be a still larger job for it in East Bay. The scattered drilling done around the north end of the bay has shown a widespread occurrence of the typical Steep Rock hematite, but the quantity available will remain uncertain until much more investigating is done. The indications, meantime, are that ore body "C" is still larger than "A." Its surface is some 375 feet below the present water level in East Bay, which, incidentally, will soon be lowered another 30 feet through the tunnel indicated on the accompanying plan of the deposits. To clean out East Bay would require several years of dredging, but further exploration may prove this to be justified.

The Steep Rock ore is of high grade, the shipments of 1,206,248 long tons in 1947 having had the following average analysis:

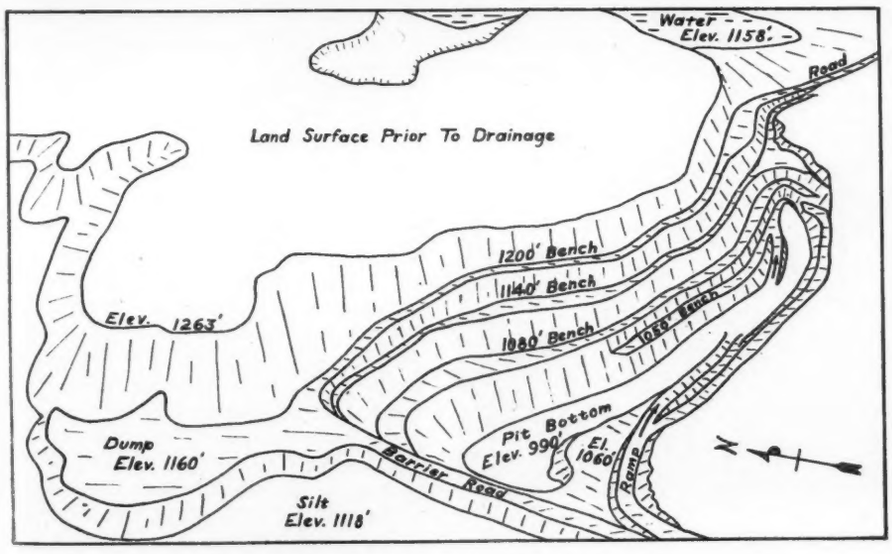
Iron	57.400%
Phosphorus	0.028
Sulphur	0.041
Silica	7.530
Manganese	0.190
Alumina	1.570
Moisture	10.170
Natural Iron	51.560

The ore as dug from the pit is separated by screening and blending into the grades required. Last year's shipments of 61,155 long tons of Steep Rock open-hearth lump ore had the following average analysis:

Iron	59.170%
Phosphorus	0.026
Sulphur	0.026
Silica	5.950
Manganese	0.160
Alumina	1.030
Moisture	5.920
Natural Iron	55.670

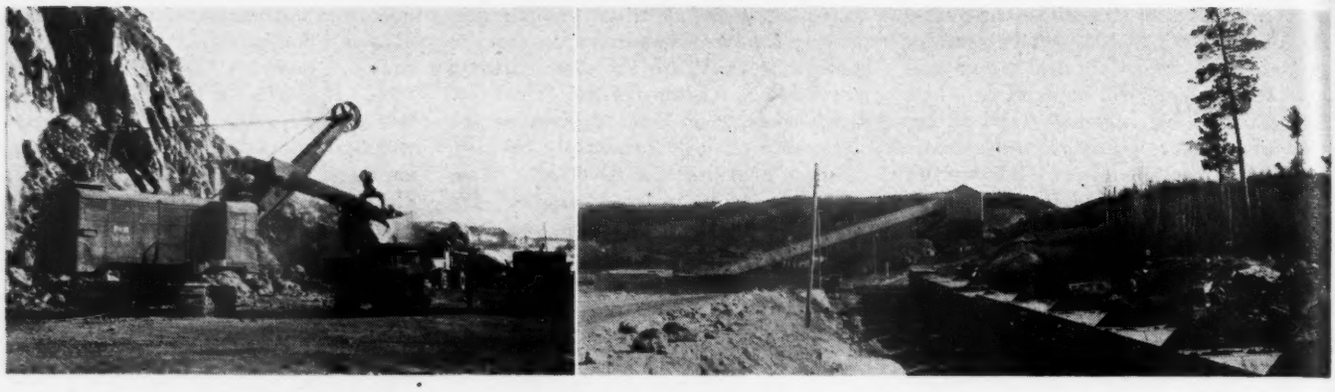
An important attribute of the ore shown by the analyses is the water of crystallization. The ore is actually nearer to the hydrated oxide of iron, goethite, than to hematite. It is the water of crystallization that makes the material so easy to reduce in the blast furnace and that has already made the Steep Rock lump ore a favorite with open-hearth operators. A 50-ton shipment that was treated last year in the Wiberg furnace at Soderfors, Sweden, proved it to be the most easily reduced ore ever handled there. The Wiberg furnace, which produces sponge iron, is capable of measuring accurately the relative reducibility of an ore, as the reaction is not complicated by the melting process, as in the blast furnace, and the exact carbon consumption is known because the coke is completely burned to carbon dioxide.

While the researches and studies of the relative reducibility of various iron ores are as yet far from complete, one can envision fairly safely the reason for the rapid reduction of the Steep Rock and other hydrated ores. The water of crystallization is held as a part of the molecule. As the water is driven off by the heat, the reducing gas comes into the intermolecular spaces to take its place, thus attacking the iron oxide in a most intimate way. In the case of hard



OPEN PIT IN DEPOSIT "B" AND EXPLANATORY DRAWING

At the top is an aerial view of "B" pit looking southeastward and showing a section of the partially drained East Bay of the lake in the background. The sketch identifies the various benches on which ore is being mined.



SCENES IN "B" PIT

Left, is a P&H 4-yard shovel loading ore into a Euclid 20-ton truck on the 990-foot bench, now the pit bottom. Before shipment, the ore is crushed and screened in the plant at the end of the railroad siding in the right-hand view.

hematite or magnetite or sinter, the reducing gas can react with the lumps of ore only on the outside surface, and thus can progress to the center by but slow degrees.

Steep Rock Mine draws its power supply from the lines of the Hydroelectric Commission of Ontario, the principal generating stations in this region being on the Nipigon River, 200 miles to the east. The ore is shipped over the Canadian National Railways to Port Arthur, where a modern ore dock was constructed by the Canadian Government in 1945. The present capacity is 30,000 tons, in 100 ore pockets. This is only half the size of the structure as designed, and the full 60,000-ton dock, capable of loading four 10,000-ton vessels simultaneously, will be required when both "A" and "B" deposits are in production. A corresponding increase in rolling stock and sidings will then also be needed.

The Steep Rock ore requires a minimum of treatment to make it ready for market. It is handled readily by electric shovels after being broken up by means of widely spaced churn-drill holes. The shovels at present are two P&H 4-yard and three Northwest 2½-yard machines. Twelve 20-ton Euclid trucks take the ore up to the crushing and screening plant alongside the railway siding. It all goes through the primary crusher, which reduces it to the 9-inch maximum size of the open-hearth lump ore. The crushed ore goes to screens which take out the lump ore, which bears the trade name of Steep Rock. Blending yields the single blast-furnace grade, called Seine River, being marketed this year.

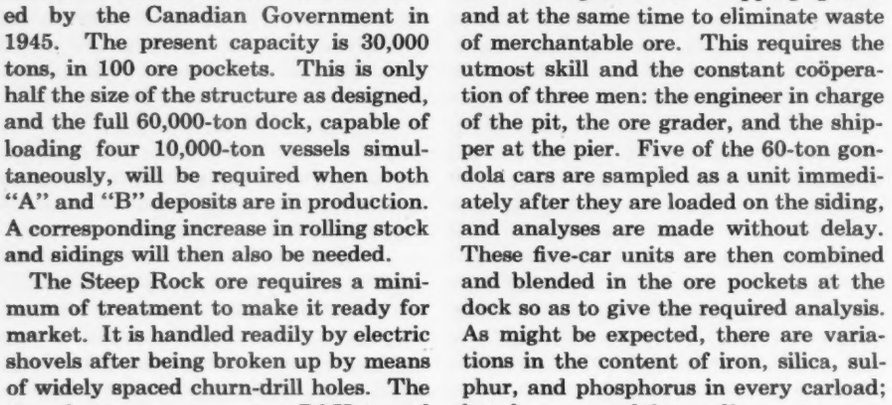
Careful blending of the ore from the various parts of the long pit is done to meet the guaranteed shipping grades and at the same time to eliminate waste of merchantable ore. This requires the utmost skill and the constant coöperation of three men: the engineer in charge of the pit, the ore grader, and the shipper at the pier. Five of the 60-ton gondola cars are sampled as a unit immediately after they are loaded on the siding, and analyses are made without delay. These five-car units are then combined and blended in the ore pockets at the dock so as to give the required analysis. As might be expected, there are variations in the content of iron, silica, sulphur, and phosphorus in every carload; but, by means of the grading system employed, the analysis of the ore as transported in the ore boats is maintained consistently at the guaranteed figures.

The Steep Rock ores are high grade and sell at a high price. A small part of the output satisfies the needs of the blast furnaces of Ontario for such ores, so the bulk of the million tons a year is available for export to the United States. It might be noted in passing that the Helen Mine of Algoma Steel Corporation produces 600,000 tons a year of high-grade, fast-reducing sinter, half of which meets the need of Algoma's own furnaces at Sault Ste. Marie, Ontario, leaving the other half for export. Thus the two iron mines of Ontario provide at present 1¼ million tons of high-grade ore for furnaces in the United States, and in exchange the Canadian furnaces draw a somewhat larger tonnage of lower-grade ores from the American iron ranges.

While the present million tons or so from Steep Rock is small in comparison with the annual total of 60 to 80 million tons from the Lake Superior region, its importance is proportionately much greater. Of the total tonnage of Lake ores, only a small part is high in grade. As the high-grade ore supply of the open-pit mines is diminishing rapidly, it is important that it be supplemented to as great an extent as possible from mines in Canada. Steep Rock is providing a significant part of this supplementary tonnage of high-grade ore.

To sum up: Steep Rock now has an established production of a million tons a year, all high in grade. When the second ore body is in full production this will be stepped up to three million tons. If present indications of ore between the two proven deposits turn out favorably, we may see a pit that will be among the largest in the Lake Superior region. Beyond this, in another bay of the lake, there are indications of another deposit, but the information at present is too meager to say what it may amount to.

Meanwhile, it is a great satisfaction to the people of Canada that they are at last able to contribute their share to the iron-ore supply of this continent.



ORE DOCK AT PORT ARTHUR

Ore is shipped by rail to Lake Superior, where it is loaded into boats bound for United States steel mills. The dock used has 100 pockets, each of which holds 300 tons. Ultimately it will be double this size, and when ore body "A" starts producing it will be called upon to handle three million tons a year. It will then be able to load simultaneously four vessels such as the one shown.

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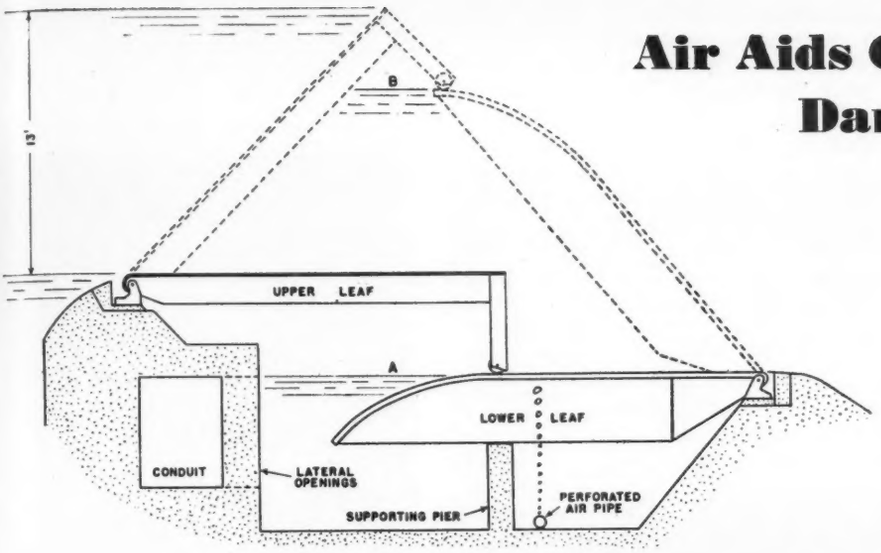


Air Aids Operation of Dam Spillway Gates

Abraham Streiff

Modern Version of Old Bear-trap River Weir Controls Overflow of Possum Kingdom Dam.

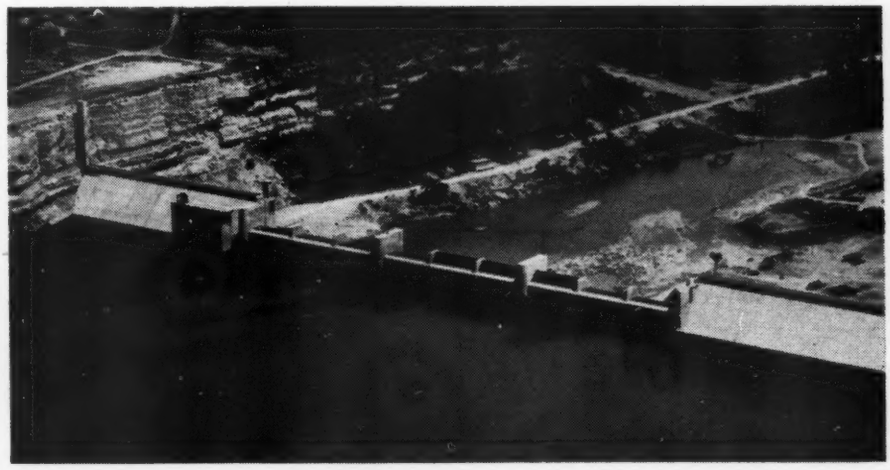
AN INTERESTING feature of the Possum Kingdom Dam in Texas are the spillway gates, which differ from conventional types in that they are designed to operate by compressed air. The dam is located on the Brazos River near the town of Mineral Wells and is the first one built of a series of thirteen planned under a multiple-purpose development project sponsored by the Brazos River Conservation and Reclamation District. This Authority was created in 1929 by the Legislature of Texas as a result of 30 years' effort by a number of public-spirited citizens of the Lone Star State intent upon conserving and harnessing the resources of the Brazos watershed.

In the arid and semiarid Southwest the water supply is, generally, markedly deficient, with storm floods at intervals that ravage the uplands and inundate the lower valleys for miles beyond a river's channel. To combat damage and to impound the floodwaters for use during dry periods, the Brazos Project was initiated by the construction of the Possum Kingdom Dam and reservoir. At normal pond level (Elevation 1000) the storage capacity is 757,000 acre-feet, and at 10 feet surcharge it totals 990,000 acre-feet.

The structure is situated at a scenic bend of the Brazos where one bank is a sheer rock bluff 200 feet high and the opposite shore is a sloping, wooded hillside. The foundation is composed of Pennsylvanian formations of limestone, sandstone, and shale. The upper strata of hard Merriman limestone rest on gray calcareous sandstone and compact, hard, so-called Wolf Mountain shale. The latter bed is of great thickness and forms the foundation for most of the dam. The maximum load imposed on this shale is only 5½ tons per square foot; the sliding factor for the spillway section is 46 percent.

No particular foundation problem was encountered, and care was taken to prevent drying out of the shale prior to pouring concrete by quickly applying a 6-inch mat of concrete. Excavating involved the removal of 150,000 cubic yards of rock and 350,000 cubic yards of earth. The principal structural materials required were 325,000 cubic yards of concrete and 7000 tons of reinforcing steel.

Possum Kingdom Dam is of the Ambursen reinforced-concrete buttress type and has an over-all length of 2740 feet. It consists of a powerhouse section 326 feet long, including the north bulkhead; the spillway, 707 feet; the south bulkhead, 600 feet; and of a 1107-foot earth dike with a concrete core wall. The buttresses are spaced on 40-foot centers and have a maximum thickness of 10 feet, diminishing toward the crest. The deck slope upstream is 10 on 8; downstream, 10 on 5.7. The deck thickness varies from 9 to 5 feet on the spillway and less



HOW GATES WORK

In the sketch, the solid lines show a gate when down and the dotted outline indicates its position when fully raised. Early, light-weight gates of this type were operated solely by headwater pressure, water being admitted under the leaves to push them up. The higher the upstream head, the higher the gates were lifted. However, the differential pressure is not sufficient to elevate the all-steel structures at Possum Kingdom Dam, so compressed air is provided to assist in the operation. As the reservoir level rises above the spillway crest, water is admitted under each gate through conduits having lateral openings. When the internal water level reaches the line A, compressed air is discharged through the perforated pipe and enters the lower leaf, which, being open at the bottom and closed at the top, is, in effect, a caisson. The air increases the buoyancy of the gate and, as more water is admitted, it rises, the upper leaf sliding over the cam-shaped upper surface of the lower leaf. If the pond level rises to the full 13-foot height of the closed gate, the internal water level will be at line B. As the upstream reservoir level drops, the water within the gate can be discharged on the downstream side to lower the gate. By pumping water under the gate and turning on the air pressure, the structure can be elevated even though there is no upstream head. It can then be locked and drained for purposes of inspection, painting, etc. The downstream aerial view of the dam shows the spillway section with three of the nine gates raised.

on the bulkheads. The height from the lowest buttress footing (Elevation 834.5) to the top of the spillway gates is 165.5 feet and to the top of the bulkheads, 189.5 feet. At normal pond level, the head on the turbines is 130 feet.

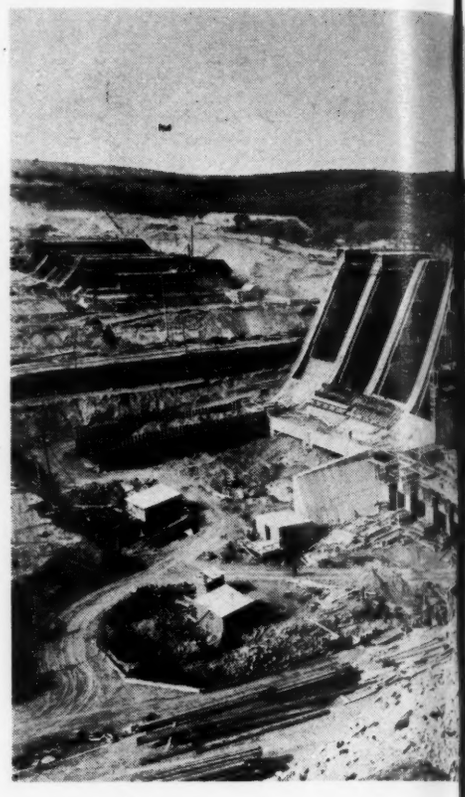
The spillway is of novel design and therefore of particular interest. Its discharge capacity is such as to take care of the flood flow from a drainage area of 20,000 square miles, of which 7000 is considered arid and noncontributing. The recorded peak flow is 165,000 second-feet, and the estimated maximum is 325,000 second-feet. The structure has nine gates separated by six low piers and two regulating piers. To provide against possible floods of exceptional volume, there is a 24-foot freeboard from the top of the gates to the crest of the spillway. Because of the great surcharge, the use of lifting gates with overhead structures was not desirable. Instead, disappearing gates were selected. When down, these leave a clear opening, except for the low separating and regulating piers between the individual gates.

The principal forms of disappearing gates are the drum and the bear-trap, of which there are numerous variations. The gates of the Possum Kingdom spillway are an improvement upon the bear-trap type. The basic principle of the design is that use is made of the difference in water pressure above and below the gate for its manipulation. To close the gate, headwater pressure is admitted under it to raise the leaves; to lower it, the water under the leaves is drained into the tailrace.

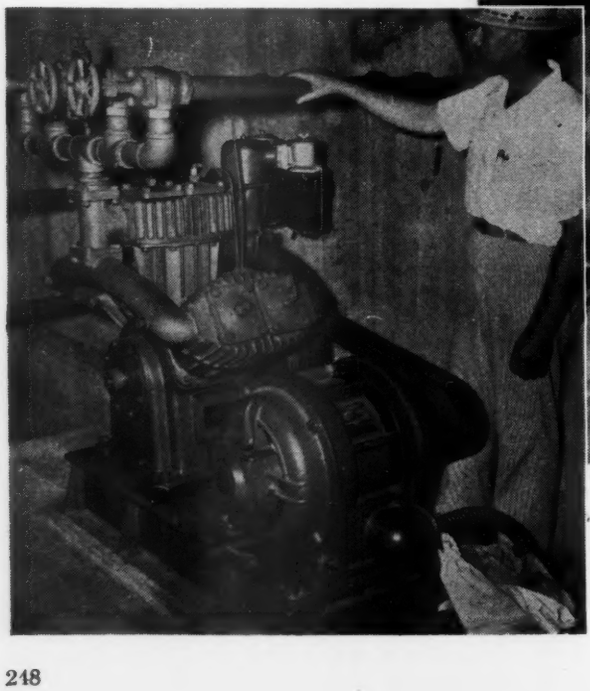
The prototype of the bear-trap was built by the Dutch hydraulician Donker at Gouda, Schiedam, and Alewein in 1770. It was re-created independently in 1818 by Josiah White and Erskine Hazard, who pioneered in water transportation of anthracite coal in the Lehigh Valley, and must be regarded as a typical American design. It was used extensively in this country, where existing examples are to be found well-nigh exclusively. The name is said to have been coined by a workman who, questioned by curious onlookers, told them that he was making a bear trap.

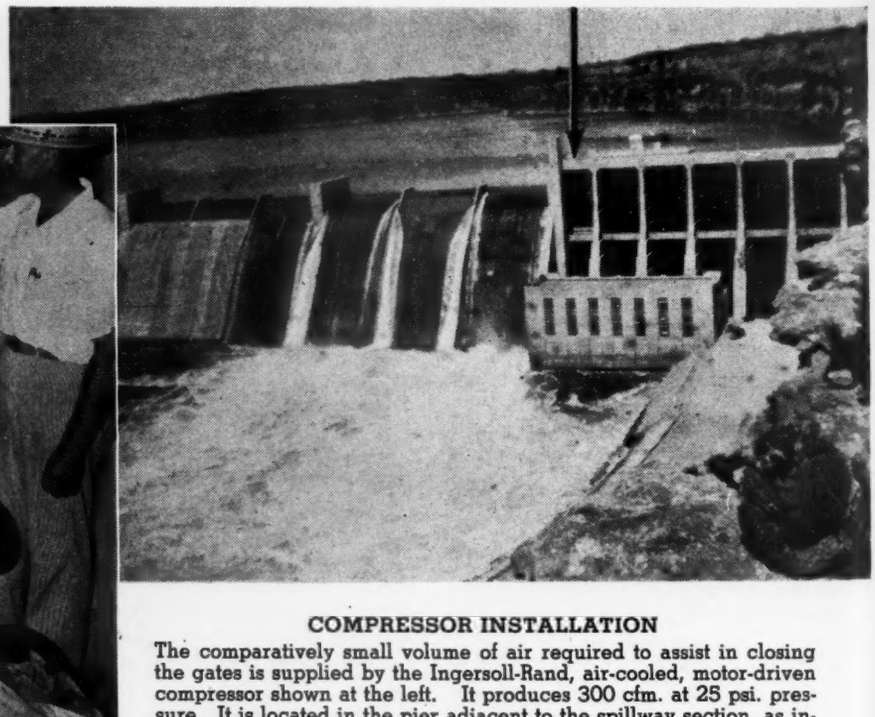
By 1819 there were already twelve bear-trap weirs in the Lehigh River. Their application spread rapidly even to France, where a "Porte Américaine" was built in the 70's in the weir of Neuville-au-pont-sur-Marne. This weir was not properly proportioned and brought the bear-trap into temporary disrepute. In a report published the same year, the French engineer and harbor expert Malézieux stated that the gate design had been discarded, and the well-known French navigation authority Lagrené said that the bear-trap was ingenious but not practical.

However, in 1882 Ashbel Welch, president of the American Society of Civil Engineers, renewed interest in the type for regulating the depth of water for inland navigation. The U. S. Engineer Corps and others then constructed many bear-traps of large dimensions for the control of the Ohio, Mississippi, Chippewa, Allegheny, and many other streams. The original White design was modified and improved by such notable engineers as Dubois, Parker, Girard, Brunot, Lang, Carro, Chittenden, Marshall, and a number of others. Beaver Dam No. 6 on the Ohio River, reared in 1904, has bear-trap gates 120 feet long by 13.2 feet high, and the late Prof. Gardner S. Williams built several of them into hydroelectric stations on the Huron River.



The next advance in bear-trap weirs was made by two Swiss engineers, Huber and Lutz. They redesigned the gate and obtained a much lighter structure by a skillful distribution of the reactive forces. The Huber gate, christened "roof-weir" by the originator, was so light and low in cost that it found its way into not only European but also American dams.





COMPRESSOR INSTALLATION

The comparatively small volume of air required to assist in closing the gates is supplied by the Ingersoll-Rand, air-cooled, motor-driven compressor shown at the left. It produces 300 cfm. at 25 psi. pressure. It is located in the pier adjacent to the spillway section, as indicated by the arrow in the picture above.

VIEWS OF DAM

Possum Kingdom Dam is on the Brazos River at a point near Mineral Wells in Palo Pinto County, Tex. It has an extreme height of 189.5 feet above the foundation rock and its power plant operates under a maximum head of 130 feet. These pictures show the site before construction began (bottom) and the dam during the concrete-pouring stage (left) and shortly before filling of the reservoir (below).

Fifteen such weirs, 98x12 feet and 78x12 feet, were incorporated in six dams on the Guadalupe River in Texas by the Fargo Engineering Company because the type was especially well adapted to cope with the great floods which occur in the Balcones fault region of that state.

For higher structures, the Huber gate was not suitable without further modification. So that its hydraulic balance could be maintained in all positions, it was given a timber facing in order to make it as light as possible. On high dams, where the timber facing is less accessible and would require too much upkeep, an all-steel gate is preferable. But this influences the hydraulic balance. When placed on top of such a structure, the water level could be considerably below the crest, necessitating special arrangements for gate control in all eventualities.

The roof-weir, when laid down, can be raised only after the water has been allowed to rise and spill about a foot deep over the top of the gate. This is not permissible in a dam with a 20,000-acre storage reservoir where such spillage might, depending upon the inflow, continue for months before the gate could be lifted. This would cause a great loss of water. Also, when spilling with a full head on the gate, the differential pressure would not be sufficient to raise the steel structure when completely down. In the old bear-trap of Neuville-au-pont-sur-Marne this was remedied by placing another Thénard flashboard, 2 feet in height, upstream. But that was not a practical solution, and on the Possum Kingdom spillway the writer applied compressed air.

For that purpose, the lower leaf of each of the nine gates was provided on the downstream side with plate-girder end frames and a plate-steel diaphragm. In down position, the lower leaf is now a caisson open at the bottom. An air line was laid on the concrete base slab under the gates, and an appropriate distribution system, with manifolds and regulating valves for the admission of air to the gates, was installed. Compressed air for the system is supplied by an Ingersoll-Rand, motor-driven, air-cooled unit having a capacity of 300 cubic feet of free air per minute at 25 pounds pressure.

When air enters the caissons, the gates immediately become buoyant and start to rise—in short, they are under complete control at all times and no water is spilled unless desired. Very little air power is required because the caissons are airtight. Under circumstances, a gate may have to be raised to full height when the water level is below the sill. This contingency has been provided for by the installation of a centrifugal pump with a capacity of 5500 gpm. This unit can be made to function like a hydraulic jack by pumping water under the gate. The caisson immediately floats the gate, and continued pumping raises it until it is closed—the position in which it can be locked and drained for inspection, painting, etc.

The gates designed for the Possum Kingdom spillway are lighter and therefore less costly than other forms of disappearing gates. Furthermore, through the introduction of caissons operated by compressed air they have been adapted for use on high overflow spillways for large-area reservoirs. The total cost of the project, exclusive of 20,640 acres of flowage land, was $5,800,000. The dam was designed by the Ambursen Engineering Company and built under its supervision by Lytle & Johnson, general contractors. Erection of the generating machinery was done under force account by the Brazos District.

Producing
BALLAST FOR THE UNION PACIFIC
at Sherman Hill

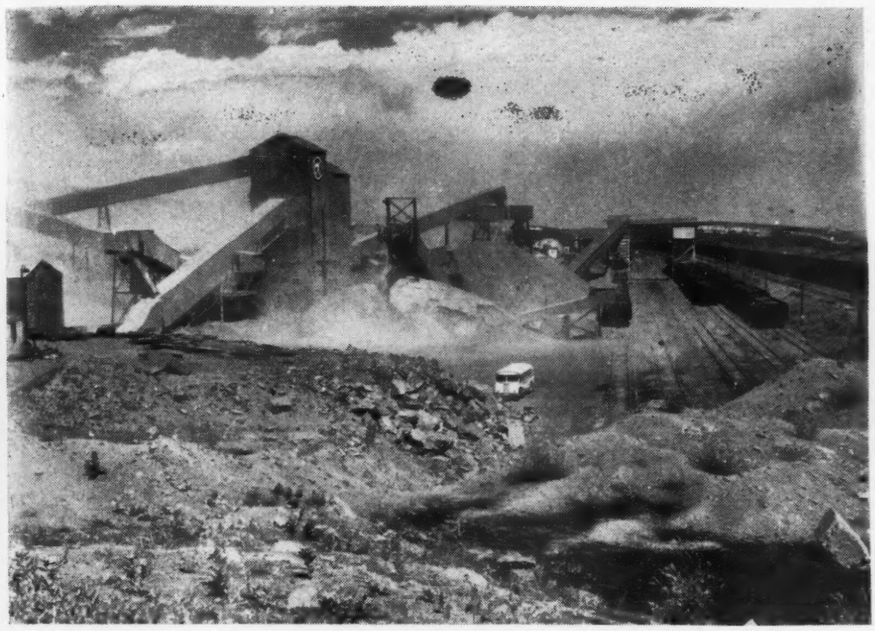
L. A. Luther

THE Irish seem to hold an all-time record in laying rail. Gen. Jack Casement of the Union Pacific Railroad relied on them, and the competing Central Pacific, with several thousand Chinamen on the payroll, is reported to have fallen back on Irish luck and brawn to win a $10,000 bet that its forces couldn't build 10 miles of track in a day. A locomotive ran over the rails in forty minutes, proving it to be "good" by then-existing standards. However, a look at the track Casement and his Central Pacific competitors built in those days—even when not racing for transcontinental laurels—would give a present-day railroad passenger the creeps. The rail was light, about 56 pounds to the yard, and rested directly on unseasoned and often crudely hewn softwood ties.

The ballast was native soil, ridged up between the rails to give stability and shed rain. Many of the native materials used melted away like sugar under the washing of freshets, puddled to mud-pie consistency under ties, and, in the bitter Wyoming winters, swelled like salt-rising dough to heave the rails out of

QUARRY OPERATIONS

Muck blasted down into coyote holes driven into the quarry face is moved out by a scraper drawn by a cable powered by an Ingersoll-Rand 2-drum, air-operated Utility hoist mounted on the rear of a truck. The hoist is also used for other hauling jobs such as that illustrated at the top, where it is about to pull a stone boat loaded with TNT into one of the holes. After a series of coyote holes has been put in and tees at their inner ends have been loaded with explosive, the passages are backfilled with quarry waste. This is conveyed through a pipe line with compressed air. The center view shows a clamshell bucket loading material into the hopper of the Pressweld concrete placement machine that is used for this pneumatic "shooting." The picture gives an idea of the height of the quarry face. A P&H 5-cubic-yard electric shovel is seen at the left loading quarry rock into a Euclid 10-ton truck for transportation to the crushing plant.



CRUSHING PLANT

Quarried rock is reduced to ballast size by repeated crushing and screening operations. A part of the plant, with stockpiles and tipples for loading the stone into cars, is shown here.

line and surface. Finding a ballast material that could be produced economically in that unmechanized era was a difficult problem for the young and then not too affluent U.P. However, in negotiating the first and highest mountain barrier on the 50-mile stretch between Cheyenne and Laramie, it was discovered that the track crossed a hill of first-class ballast material that extended right to the surface.

Its outcrop at many points seems to be ordinary granite, and automobile tourists still stop to photograph storm-tortured conifers that appear to have their roots in solid rock. Having weathered and disintegrated through the centuries, the rock is relatively friable, breaking up freely into small cubes of reddish color. This material became nationally known among railway people as Union Pacific's "Sherman Hill Ballast," and many thousands of carloads of it were placed in track in Wyoming, Nebraska, Colorado, and Kansas.

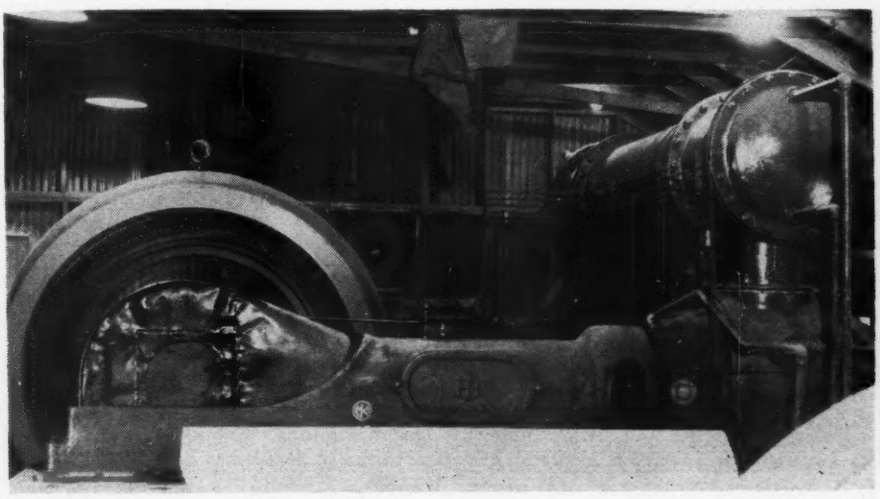
In recent years, the rock was loosened up for loading with power shovels by drilling deep holes by means of Jackhamers. Large groups of holes were sprung, loaded heavily, and fired in unison. Sherman Hill Ballast was cheap, provided good drainage, was an easy material with which to maintain good track surface and make tie renewals, and gave the track quiet, slightly cushiony riding qualities.

As locomotives grew many times heavier and belched out cinders in great volumes to foul ballast, and as trains became correspondingly longer and heavier, this brittle material suffered from mechanical wear and was unstable in the cyclonic drafts created by 90-mile-an-hour streamliners. Always a pioneer in using heavy power to move heavy trains on fast-freight schedules and in combining speed with comfort in passenger service, the U. P. made extensive explorations and tests of various ballast sources. It produced considerable material from crushed boulders in a glacial moraine near Evanston, Wyo. Then the investigations revealed that the big hill west of Cheyenne was literally as rich in ballast as the "Big Rock Candy Mountain" of the range-rider song is in "rock candy." A rugged covert for sniping Indians during construction days, and a rendezvous for blizzards that still make winter railroading a duel with the elements, it gradually has made amends for the hardships it has imposed.

Core drilling disclosed a lifetime supply of excellent hard granite at Granite Canyon, some 20 miles west of the Wyoming capital and 10 miles east of the Sherman Hill pits at Buford. In early 1945, Morrison-Knudsen Company, Inc., began operating the world's largest crushing plant devoted exclusively to producing railway ballast. It has a capacity of 80 carloads a day, and two million cubic yards has thus far been shipped to points in the four-state area previously served by the Buford pits. As much as 71,000 tons has been stockpiled over the conveyor-equipped tunnel which delivers to twin car-loading tipples.

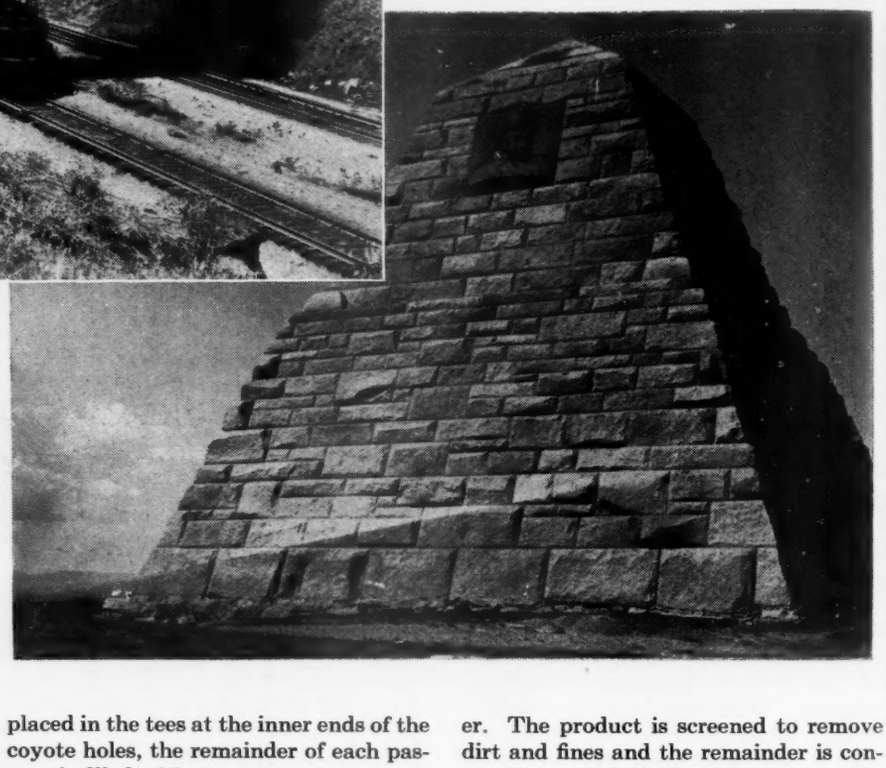
In opening the quarry, drilling was done with eight FM-2 wagon drills mounting X-71 drifter drills. Some experimenting in production drilling was done with churn drills, but the present practice is to use 3x4-foot coyote holes. Spacing and length of the coyotes is calculated with relation to height of face. Those in a typical group of twelve range in length from 40 to 70 feet and have 15-foot tees at their inner ends. The latter are charged with an aggregate of 131,000 pounds of Government surplus TNT, which is fired simultaneously and shatters 80,000 cubic yards neat, producing approximately 300,000 cubic yards of broken rock.

Drilling inside the coyote holes is done with J-50 Jackhamers. Muck is removed by a scraper drawn by an ingeniously truck-mounted Ingersoll-Rand HNN-1J double-drum, Utility air host. There are two of these units and they also pull loads of explosive into the holes. Each hoist has a cable pull of 2000 pounds when supplied with air at 80 psi. pressure and a cable speed of up to 130 feet per minute. Two No. 25 sump pumps



AIR COMPRESSOR

Compressed air for drilling, placing backfill in coyote holes, operating gates in the crushing plant, and for other purposes is furnished by three Ingersoll-Rand compressors, of which the synchronous motor-driven PRE-2 machine shown here is the largest.



SHERMAN HILL, TRAIN AND MONUMENT

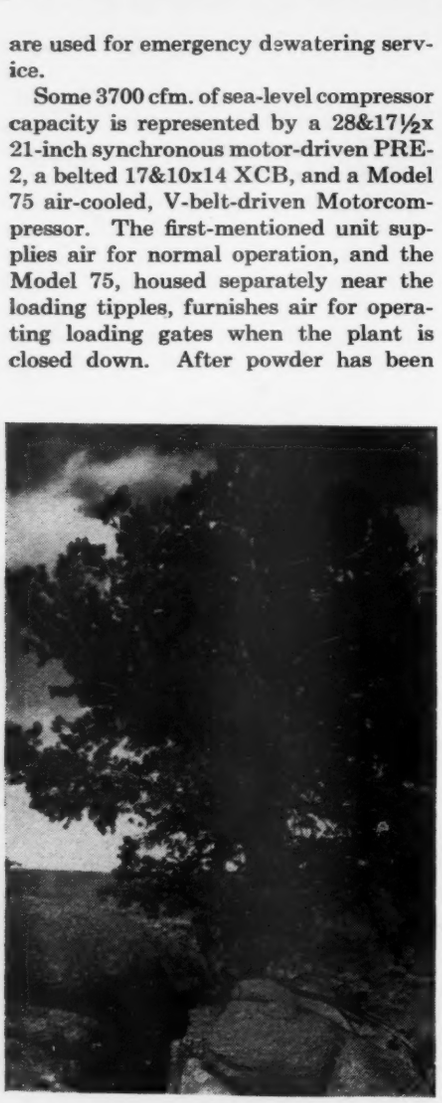
These pictures show a Union Pacific 4000 Series Mallet locomotive, reputedly the largest in existence, approaching Sherman Hill summit eastbound with a train of Wyoming coal, and a 60-foot granite monument on top of the pass inscribed to Oakes and Oliver Ames, early U.P. financiers and officers. The line now crosses the pass at a lower elevation, having been relocated early in the company's history.

are used for emergency dewatering service.

Some 3700 cfm. of sea-level compressor capacity is represented by a 28&17½x 21-inch synchronous motor-driven PRE-2, a belted 17&10x14 XCB, and a Model 75 air-cooled, V-belt-driven Motorcompressor. The first-mentioned unit supplies air for normal operation, and the Model 75, housed separately near the loading tipples, furnishes air for operating loading gates when the plant is closed down. After powder has been placed in the tees at the inner ends of the coyote holes, the remainder of each passage is filled with quarry waste to act as stemming. As the material is "shot" in with compressed air, the old XCB compressor is operated to meet the additional demand for air whenever both drilling and backfilling are in progress. The quarry waste is hauled to the portal of a coyote hole in Euclid trucks and unloaded by a crane-operated ½-cubic-yard clamshell bucket into the hopper of a 1-yard Pressweld concrete placement machine. From the latter it is delivered into the hole through piping that is gradually shortened as filling progresses. The adoption of this pneumatic method has made it possible to backfill three holes in a shift, whereas formerly three shifts were sometimes required to backfill one hole when the material was scraped in and then placed by hand shoveling. Also, the material is stowed more compactly and, consequently, in greater volume.

Stone shot down at the quarry face is loaded into 10-ton Euclid trucks by two power shovels: a P & H 5-yard all-electric and a 2½-yard Bucyrus-Erie diesel. It is hauled to the crushing plant, where it is first reduced to a maximum size of 9 inches in a 42-inch McCully cone crusher. The product is screened to remove dirt and fines and the remainder is conveyed to a 7-foot Symons cone crusher that reduces it to a maximum of 2½-inch size. This material is delivered to a 20,000 cubic-yard stockpile over a tunnel containing a conveyor belt that provides controlled feed to three secondary Symons cone crushers: one 5-foot and two 4¼-foot units. The ballast thus produced is of one grade: 1¾ inch minus to ½ inch plus. It is delivered by belt to a main stockpile, from which it is loaded into cars as ordered by the railroad. Some screenings or chips that are obtained as by-products during the sizing process are also shipped to be used in mastic placed at crossings, on station platforms, etc. An excellent grade of heavy riprap is likewise produced by selecting suitable pieces when the blasted rock is being loaded into trucks at the quarry face. This is stockpiled and shipped out as ordered.

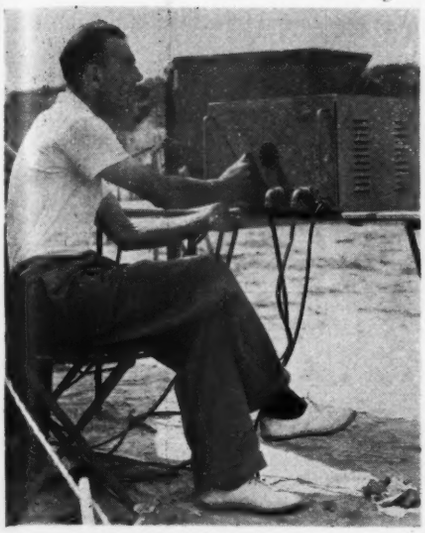
F. E. Newell is project manager of the operations for Morrison-Knudsen at Granite Canyon. Ted Lewandowski is plant superintendent, and John Dissaro is quarry foreman. The production and use of the stone by the Union Pacific is under the general supervision of W. C. Perkins, chief engineer.

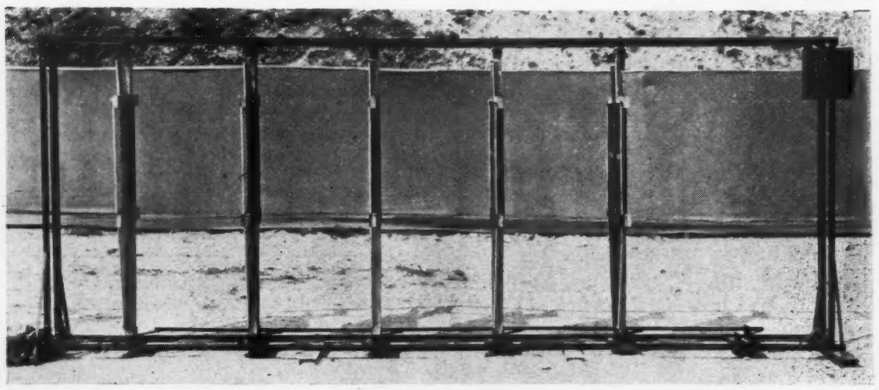


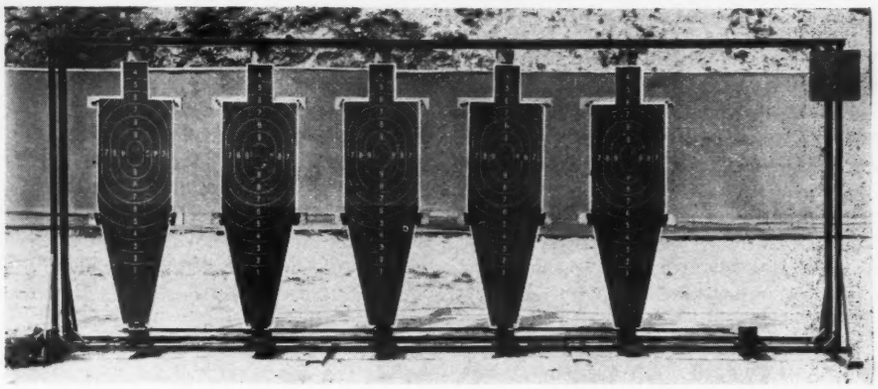
ROOTED IN ROCK

A pine tree growing out of a cleft in the disintegrated granite of Sherman Hill. This divide is at an altitude of 8235 feet and is the highest pass on the Union Pacific line across the Rockies.

Air Power Turned Targets at Olympiad





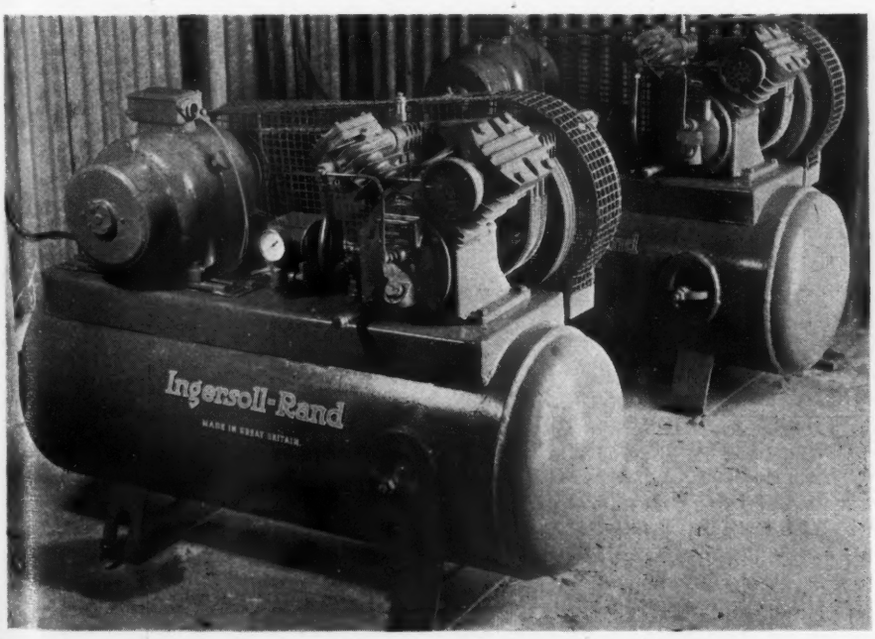


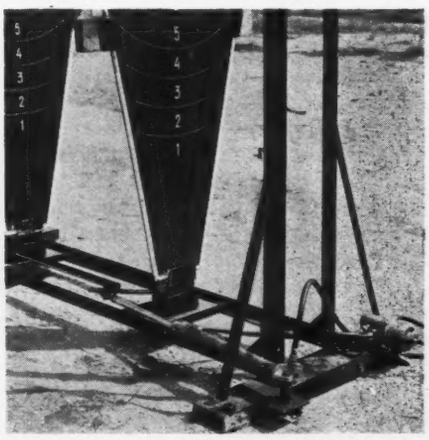
TARGET CONTROL STATION

The dial in the center of the box was set to display the targets for a specified number of seconds. When the operator pressed the button on which his thumb rests, the targets automatically snapped into shooting position and back out of view. The lines leaving the box extend to the air-cylinder control valve. The pictures at the right show the targets standing edgeways to the eye (top) and in shooting position.

UPON being told that compressed air was used in connection with one of the sports events at the recent London Olympiad, the immediate response would probably be: "Whatever for?" Why, for the rapid-fire pistol-shooting contest at targets that were positioned edgeways to the participants before the starting signal was given. Turning of the targets at the 1948 games was controlled with equipment of the electronic type designed by technicians of the Royal Air Force and was done with a precision that amazed the managers of the shooting teams who came to check the timing mechanism with stop watches. As the R.A.F. expressed it: "That was like someone asking us to check our stop watches by means of an old alarm clock."

There were four batteries of five targets each at the shooting range and each battery was provided with a solenoid-controlled air cylinder. The piston rod of the latter was connected to a long angle iron to which were bolted a series of bell cranks, one at the base of each target. The electronic control equipment is encased in a metal cabinet. Seated in front of this station, the operator pressed a button on the front panel, thus actuating the solenoid valve that admitted air to the cylinder. Automatically, the targets were given a quarter turn and, after remaining visible for a predetermined length of time, snapped back to their original position. Compressed air for the purpose was supplied by two 3-hp. Type 30 machines mounted on 20x48-inch horizontal air receivers. These units were loaned to the committee by Ingersoll-Rand Company, Ltd.

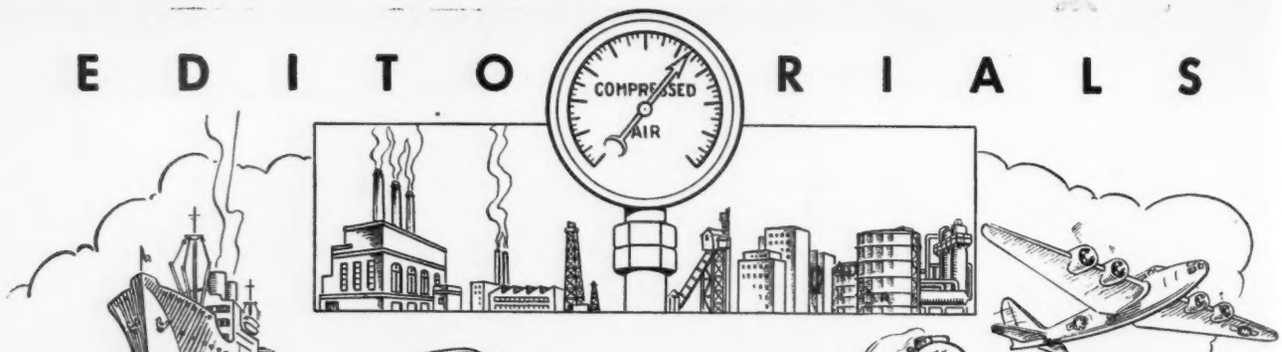




HOW TARGETS WERE TURNED

Above, extreme right, is the valve that controlled the admission and exhaust of air from the cylinder in the foreground. Through connecting linkage the piston turned the targets 90° and back to their original position. The compressors that supplied the air are at the left.

EDITORIALS



CONSERVING OUR RESOURCES

EXCEPTING times of war, Americans have seldom had to conserve natural resources. Our periods of rationing and shortages have been too brief to impress us seriously. The average citizen takes it for granted that somebody will somehow keep us supplied with metals, fertilizers, water, and other requisites for a life of comparative ease. If there is a shortage of oil for heating his home, he can switch to coal. Or, if this is financially or economically not feasible at the moment, he can buy relatively inexpensive electric heaters.

Our nation has been generously endowed by nature, but we are beginning to run low on some essential materials. Another war on the scale of the recent one would find us scraping the bottom of some of the barrels that we once thought were inexhaustible. There is every reason that we give heed to the problem now instead of waiting until an emergency arises.

Conservation does not mean stopping the use of something that is scarce, but rather using it with discretion. Materials derived from growing things are capable of replenishment through replanting. Others such as metals and petroleum are in a different category. Fortunately, science has developed ways of making gasoline artificially, but it will no doubt be more expensive than the fuel we now have. No one has yet discovered means of creating metals, although the nuclear scientists may someday solve the riddle of transmutation on a commercial basis.

In the meantime, it is incumbent upon us to put into effect some organized scheme of husbandry. This involves a program of education. Actually, it is important to save scrap during peacetime, but the present shortage of this material is proof that too few people are aware of that fact. Engineers, too, can do a good turn for conservation by specifying substitutes for scarce materials wherever this is possible. Plastics can be employed instead of metals for many purposes without an appreciable loss in efficiency. But if metals are essential, they can be protected against erosion and corrosion by metallurgical processes such as electroplating. Even wooden structures can be safeguarded against decay by applying coats of paint at the proper time.

This, however, is not a program for the individual. Each person can help by using common sense, but the movement needs the organized guidance of the Government. Bills designed to bring this about have been introduced in Congress but not passed. Others will be put before the solons next January, and it is to be hoped that they will receive the consideration they deserve.

PRECIOUS WATER

A CENTURY ago California was searching for gold; today it is seeking water. Gold founded and nurtured the vast Western Empire, but only water can sustain it now. Southern California, which once advertised for more people, would now perhaps like to close its gates, but can't. Having gained momentum, the flow of population to that climatically favored area continues unabated, and no one can foretell when it will slow down. Meanwhile, authorities are striving frantically to cope with a water problem that grows more serious day by day.

When plans were put underway to convey Colorado River water 400 miles to the Los Angeles section, this potential supply line was looked upon as of purely supplemental importance. Most of the coastal-plain communities were pumping nearly all the water they needed from underground. Since then, unprecedented eras of drought have lowered the water table drastically, and in the same period spectacular influxes of people have added to the gravity of the situation.

Almost providentially, the 200-million-dollar Colorado River Aqueduct was completed in time to serve the vital war industries that sprang up in Southern California after the Pearl Harbor attack. More and more cities turned to this gigantic hose to slake their thirst. This has gone on until the aqueduct is no longer considered a supplemental medium of supply. Instead, it is openly called the region's life line.

When the aqueduct went into service in 1941, thirteen municipalities elected to take water from it. Now it is serving 26. In the meantime, the aggregate population of the original thirteen users has increased by more than a million and is now estimated at around 3½ millions. Their assessed valuation has more than doubled and today stands at 3½ billion dollars. This increase is attributable largely to the establishment of additional industries, all of which are dependent for their existence upon a continuing supply of water.

In 1941 the aqueduct carried an average of 8,370,000 gallons of water daily. During 1948 the daily average will be around 134,000,000 gallons. The most recent customer to be added is San Diego which, last December, put in service a 71-mile connecting aqueduct that was pushed to completion by the U. S. Navy because of its stake in defense plants in the area concerned.

A change in the weather cycle would lighten but not solve the problem. Theoretically, Southern California gets 15 inches of precipitation annually. Actually, it received only 4.13 inches in 1947, which was the driest year since the keeping of weather records started 70 years ago. A return to normal rainfall conditions would partially replenish the underground reservoirs and permit them to be drawn upon for a substantial proportion of the needs. In 1941 these subterranean sources contributed such a large share of the requirements that only 4 gallons of water per capita had to be delivered from the Colorado daily. This year the river is supplying around 41.

In the face of this situation, California is vigorously seeking a permanent Supreme Court allocation of Colorado River water for the three southern-basin states. The Colorado is literally and figuratively the "last ditch" for Southern California, and the region's continued growth is intimately bound up with the establishment of water rights that will provide a surplus for the future.

This and That

Fires from Tires

Fires consumed $2,000,000 worth of motor vehicles and equipment in 1946. Some of them are attributable to tires, especially to those on the rear of semitrailers. They are usually started by running a tire flat or with little air pressure, in which condition repeated flexing generates heat that eventually causes the tire to burst into flames. The air temperature, direction of the wind, and speed of travel all have a bearing on the incidence of overheating. The obvious preventive is to keep tires inflated properly and to remove foreign, friction-inducing objects from them.

★ ★ ★

Broadening Utility of Plastics

A transparent plastic that can be heat treated much as metals are to condition it for certain applications is announced by The M. W. Kellogg Company. It is similar in structure to the hydrocarbons of petroleum, but resists chemical attack because the hydrogen is replaced by fluorine and chlorine, which make up four-fifths of its weight. The plastic, called Kel-F, is therefore unusually stable and unaffected by acids and alkalies. These attributes suggest its use as pump and valve packings and valve seats in equipment handling corrosive liquids or gases, as well as for laboratory and instrument tubing. It has good "cold-flow" characteristics, which means that it deforms slightly under pressure but returns to its original shape when the pressure is released. This property indicates that it is suitable for making seats for air or gas safety valves which are closed for long periods.

A New Jersey firm is now manufacturing washbasins and sinks from Lucite, a du Pont plastic. These products are formed by a process combining blowing, pressing, and vacuum-drawing. The basins range in weight from 1¼ to 7¼ pounds, and models are available for airplanes, trains, autotrailers, and homes. The material is affected by a few household chemicals, but tests indicate that it has a long life under normal service conditions. Abrasive cleansers will scratch its surface, but they are unnecessary because Lucite can be cleaned with soap and water.

The newest use for nylon is as a textile machine part known as a flyer block. The spindles of the conventional blocks require lubrication, and as they whirl at from 8000 to 15,000 rpm., there is a tendency for them to throw oil on the yarn. As nylon blocks need no lubrication, this cause of yarn spoilage is eliminated.

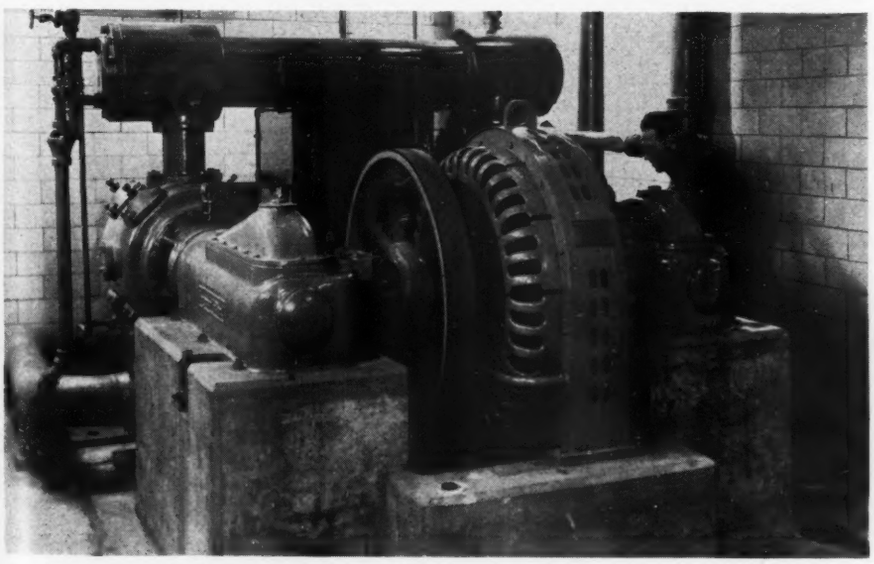
★ ★ ★

Underwater Tunnels in South

The increase in automobile traffic has made the South tunnel-conscious. Crossings over waterways are becoming bottlenecks when bridges are open to let boats through and, lacking elevated points that will permit erecting high-clearance spans, subaqueous bores offer the most practical solution. Mobile, Ala., initiated the trend when it built a $4,000,000 tube underneath the Mobile River just prior to the recent war.

Now Houston, Tex., is constructing a 3400-foot tunnel under the ship channel that connects it with the Gulf of Mexico. It is expected that the bore will cost $7,500,000 and be ready for service in eighteen months. Galveston, Tex., has taken bids on a mile-long tube under the bay. It is estimated to cost $17,000,000 and will involve the building of an artificial island 2000 feet long and of 4000 feet of trestle approach. New Orleans is planning an $8,500,000, four-lane tunnel under an intercoastal waterway. Jacksonville, Fort Lauderdale, and Miami, Fla., are all considering such passageways to solve traffic congestion. Norfolk, Va., is talking about a bore under its ship channel, and Baltimore, Md., is trying to decide between a bridge and a $45,000,000 tunnel to carry cars across Chesapeake Bay.

The success of the Mobile tube is largely responsible for the current activities. Wilmerding & Palmer, Inc., of Mobile served as engineering and financial consultants on that pioneer southern bore, and Wayne F. Palmer of that concern has since formed the firm of Palmer & Baker, Inc., which designed the Houston and Galveston tunnels. The Mobile crossing was built by assembling steel tubes in sections, sinking them in an excavated trench, and then joining them. Since it was opened in 1941 it has carried fifteen million vehicles without an accident. Tolls are now netting around $450,000 a year over and above operating expenses.



LUNGS OF A RESEARCH CENTER

The main laboratories in the new research center of The B. F. Goodrich Company at Brecksville, Ohio, are divided into 112 rooms, each 10x26 feet, by steel partitions that can be moved to combine any number of them into a larger working space. Each room is provided with gas, electricity, water, steam, and compressed air. The last-named utility is piped from the Ingersoll-Rand synchronous motor-driven compressor shown above.

★ ★ ★

Pressurized Oil-filled Power Line

Compressed air was used in several ways during the recent installation of one of the few 138,000-volt, high-pressure, oil-filled pipe-line cables in this country for the transmission of power. The San Antonio (Texas) City Public Service Board put in 58,675 feet of the underground cable to connect its "B" steam-turbine generating station with the outlying Olmos and Grandview substations. The 7½-mile Olmos line is one of the longest of its type so far put in service. The Grandview cable is about 3¼ miles long.

The enclosing steel pipe is 5 9/16 inches in outer diameter and has a .258-inch wall thickness. It was shipped in 40-foot lengths fitted with bell-and-spigot ends to insure a smooth inside finish. Prior to field welding, the inner surfaces of the ends were wire brushed with pneumatic tools and swabbed with oil to remove rough spots. Segments up to 1770 feet

long were joined before testing the pipe for leaks and running in the cable. Testing was done with air at 400 psi. pressure supplied by an Ingersoll-Rand Type 20 high-pressure compressor. To insure dry air, special equipment was used to remove entrained moisture. One end of each section was left open until the escaping air reached a dew point of minus 40°F. It was then closed and the internal pressure built up to the prescribed level.

Ordinarily, cable is pulled in by a pilot wire that is pushed through each pipe length prior to welding and spliced to the one that precedes it. In this case, however, the cable was run through the entire welded segment of up to 40 pipe lengths and more by air pressure. At first, a wooden dumbbell-type "rabbit" was blown through with a pilot line attached to it. This went so easily that a closer-fitting "rabbit" was made from two rubber pistons and a connecting rod. The three electric cables were fastened to this and were found to move ahead readily under air at from 10 to 12 psi. pressure.

As a further precaution against admitting moisture into the line, the cable was shipped to the job with lead covering. This was stripped off and reclaimed as the cable was introduced into the pipe. Special insulating oil for filling the latter was delivered in five 10,000-gallon tank cars, which were first decontaminated and dried. The space on top of the oil was charged with nitrogen to exclude moisture-containing air during transit. Nitrogen was also put in the pipe as the cable was drawn in. When in place, the remaining space in the pipe was filled with the oil, which is maintained under 200 psi. pressure by pumps in the power station. The line was installed by General Electric Company.

★ ★ ★

New 20th Century Limiteds

Since June 15, 1938, the New York Central Railroad has been running a Twentieth Century Limited daily each way between New York and Chicago and it has probably become the best-known high-speed train in the world. On September 17, two new Limiteds went into service, replacing those that had been operated for a decade. They represent an expenditure of $4,000,000 and incorporate the most modern equipment available for rail transportation. The trains are drawn by diesel-electric locomotives at a top speed of 85 miles per hour on the same time schedules that have been in force for some years. All cars are connected by telephone, and between New York and Buffalo, a distance of 435 miles, passengers may place long-distance calls by radio-telephone. Relay stations that will extend the service the length of the trip are not yet installed. Foam-rubber seats and mattresses, fluorescent lamps, and circulating ice water are some of the luxuries provided for travelers. Jerky starts and stops are eliminated by tight-lock couplings. An alarm system warns trainmen of impending hotboxes in the roller-bearing journals; and electropneumatic brakes automatically vary their pressure in accordance with the train speed. Compressed air opens the car doors when bars on them are pressed down slightly.

★ ★ ★

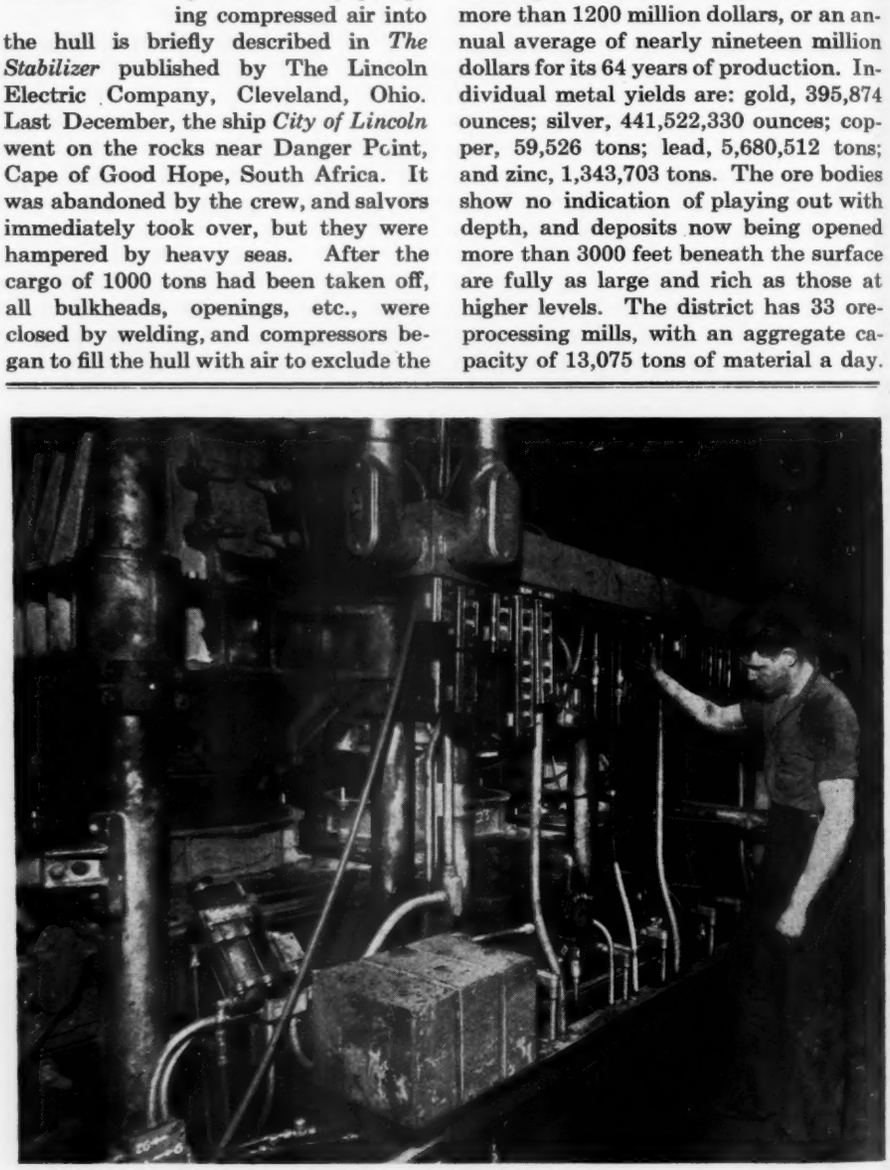
Salvage of "City of Lincoln"

How a badly damaged 12,000-ton vessel was kept afloat for months by continuously pumping compressed air into the hull is briefly described in *The Stabilizer* published by The Lincoln Electric Company, Cleveland, Ohio. Last December, the ship *City of Lincoln* went on the rocks near Danger Point, Cape of Good Hope, South Africa. It was abandoned by the crew, and salvors immediately took over, but they were hampered by heavy seas. After the cargo of 1000 tons had been taken off, all bulkheads, openings, etc., were closed by welding, and compressors began to fill the hull with air to exclude the water that was coming in through rents in the bottom. After four months, the vessel was floated clear of the rocks. It was towed 100 miles to Cape Town, with eleven compressors continuously operating to keep the water out. Even after it had been docked, six machines remained in service until the torn bottom plates could be made watertight.

★ ★ ★

Coeur d'Alene Wealth

Relatively few mining areas have shown the concentrated mineral wealth of Idaho's Coeur d'Alene District. The U. S. Bureau of Mines gives it a total output valued at more than 1200 million dollars, or an annual average of nearly nineteen million dollars for its 64 years of production. Individual metal yields are: gold, 395,874 ounces; silver, 441,522,330 ounces; copper, 59,526 tons; lead, 5,680,512 tons; and zinc, 1,343,703 tons. The ore bodies show no indication of playing out with depth, and deposits now being opened more than 3000 feet beneath the surface are fully as large and rich as those at higher levels. The district has 33 ore-processing mills, with an aggregate capacity of 13,075 tons of material a day.



PUSH-BUTTON FOUNDRY MOLDING MACHINE

This machine automatically produces multiple sand molds for pouring castings and stacks them six high ready to receive the molten metal. It is used in the Cleveland, Ohio, plant of the Westinghouse Electric Corporation and was developed by that concern and the International Molding Machine Company. All operations are performed in proper sequence by compressed air and hydraulic power under complete electric timing and control. First, sand is blown into a flask to make a preform of a mold. Next, the sand is squeezed around a drag pattern in the flask bottom under a pressure of 50 tons by a head carrying a cope pattern. Then the drag pattern is removed and the flasks are stacked preparatory to moving them by conveyor to the pouring platform.

Industrial Notes

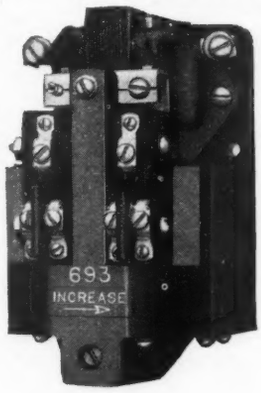
Although atomic-energy power plants are some years in the future, a short name has already been coined for them. It is "nuen," derived from the first syllables of the words nuclear and energy. It was coined by the Kellex Corporation for a display model prepared by it under the auspices of the Atomic Energy Commission.

The American Can Company has developed a machine to test the tenderness of peas as they are canned. Called Tenderometer, it computes and indicates the force required to cut through peas with keen knives. Permission to manufacture the device without payment of royalty has been granted canners of this country and Canada.

The United States Rubber Company heats a new 30x50-foot sandblasting room with wrought-iron pipe coils embedded in the concrete floor. This eliminates exposed pipes and heating elements on which fine sand accumulates. Metal tanks are cleaned in the room before they are coated with rubber.

Test cross lines of a new traffic paint showed little evidence of wear after two months of service at a highway intersection in Camden, N. J., that is considered to be the second busiest one in the state. Lines laid with paints currently used were almost obliterated in the same period. The new paint is a development of Hercules Powder Company.

A pneumatic timer for machine tools, conveyors, automatic processing equipment, etc., had been produced by Cutler-Hammer, Inc. Measuring 2¾ inches in width and 4⅞ inches in height, the device fits into restricted spaces. Adjustment covers a range of from 0.3 seconds to 3 minutes, and reset is well-nigh instantaneous. The unit is available with



either one or two timing steps. With the latter, individual adjustment of each step permits performing two separate timing functions on one instead of two relays.

A new magnetizing unit promises to be a household boon. It will magnetize screw drivers so that screws can readily be held while being inserted in inaccessible places. Women can magnetize scissors with it to pick up pins. The unit plugs into any electrical outlet and also demagnetizes.

The Copper & Brass Research Association reports that the Bell Telephone network is made up of 113 million miles of wire, enough to encircle the globe 4520 times. There are 433 parts in a telephone, many of them of copper, brass, or bronze. The nation's 30 million telephone sets therefore contain approximately 13 billion parts, not including those in the phone system itself.

HEAVY-DUTY TRAILER

Shown here is the model TB-4030 bottom-dump trailer which the Easton Car & Construction Company has recently added to its line of heavy-duty equipment. Designed to haul 32-ton loads of bituminous coal in strip-mining operations, the vehicle features a radial, air-powered gate that can be controlled either from the cab of the tractor or from the rear of the trailer. Wheels are fitted with 16:00x24, 24-ply, lug-type tires and brakes are air operated.

New 10-car stainless-steel trains now being constructed for New York City's subway lines will have fluorescent lights, illuminated station maps, and a public address system to announce station stops. Their antifriction journal bearings will run from 100,000 to 150,000 miles between inspections, as compared with the present average of 2000 miles.

The rubber division of Raybestos-Manhattan, Inc., recently supplied a southern chemical plant with a 300-foot flexible rubber hose 18 inches in diameter for carrying slurry through a tunnel. It was shipped in twelve 25-foot lengths, each weighing 1425 pounds. This is believed to be the longest large-diameter hose ever made.

Molykote is the name of a new dry-type, high-pressure lubricant produced by The Alpha Corporation. Composed mainly of molybdenum-disulphide powder, it is said to have an extremely low coefficient of friction and the capacity to prevent galling, seizing, or metal-to-metal contact at bearing pressures of more than 100,000 psi. It is reported to work equally well at high or low sliding velocities, to stand up under extremes of temperature, and to cling tenaciously to smooth metal surfaces. Ten ounces of the lubricant will coat 500 square feet. It may be used as a powder or, mixed with S. A. E. No. 10 motor oil, as a paste. It is available in 10-ounce shaker-type cans.

Pictured is a new Vulcanaire—an air-driven attachment manufactured by Vulcan Tool Company and used for converting machine tools such as jig borers and vertical mills into precision grinders. It is the second model and is designed for grinding holes ranging in diameter from 1½ to 4 inches in hardened steel. The original unit grinds holes from 1/16 to 1½ inches in diameter. Both are

equipped with interchangeable adapters which enable them to fit the chucks of most types of machine tools. Accessory equipment used with the attachment includes an air cleaner, a regulator, an air gauge, an oiler, and a dust collector, all of which are mounted on a portable stand that can be placed near the work.

A few years ago, George N. Jeppson, chairman of the board of directors of Norton Company, Worcester, Mass., conceived a new process by which abra-

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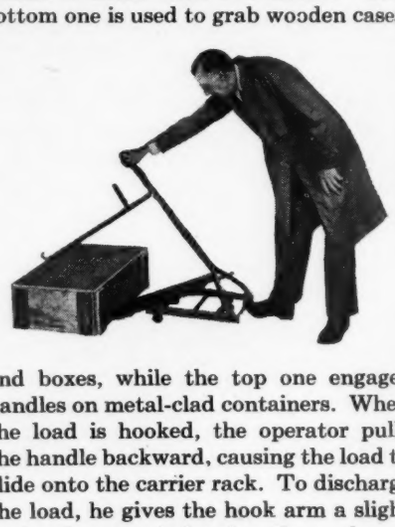
sive grinding wheels could be made faster and better than they were then being produced. The company's development engineers proved his ideas sound by turning out wheels experimentally in hours instead of days. When a pilot-plant test also was successful, ground was broken for a $4,300,000 factory in April, 1947. Although only recently dedicated, it and the pilot plant combined have already made ten million wheels by the new method.

A small hand truck for moving boxes, cases, etc., has been placed on the market by Techtmann Industries. The Hook-'N-Haul, as it is called, has a tilting carrier rack of parallel steel plates and is arranged so that forward movement of the truck handle places it in the loading position. An arm extending from the handle is fitted with two hooks. The bottom one is used to grab wooden cases

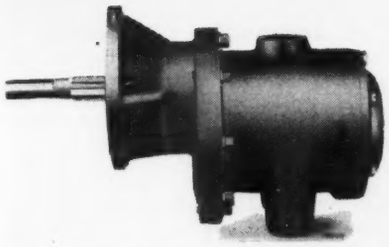


and boxes, while the top one engages handles on metal-clad containers. When the load is hooked, the operator pulls the handle backward, causing the load to slide onto the carrier rack. To discharge the load, he gives the hook arm a slight push, thus overbalancing the rack and allowing the load to slide onto the floor. The truck is of all-steel construction and is equipped with one swivel and two stationary casters.

Wearing an M.S.A. Coolband prevents perspiration from dripping into eyes and on glasses and goggles. Made for industrial use, it is a light-weight sponge-rubber band that is said to fit without binding and can be cleaned with soapy water and sterilized.

Included in the conveniences of an automobile bus used for special traveling missions of the personnel of Goodyear Tire & Rubber Company is a circulating water system that supplies a kitchen, shower bath, and lavatory. The pressure of compressed air, obtained from the braking system, forces water from an 80-gallon tank through the pipes to the various outlets.

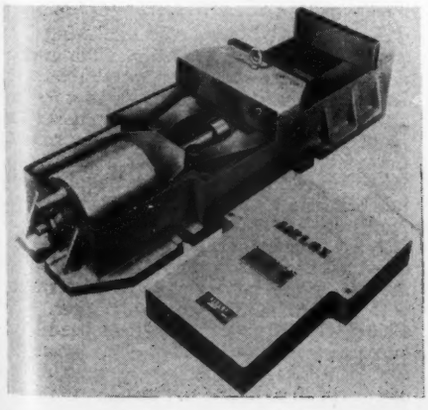
Small and compact air motors to serve as starters for internal-combustion engines are now being built by Ingersoll-Rand Company. Of the Multi-Vane type, the units are made in two sizes that



develop 9 and 20 hp., respectively, when operated with air at 90 psi. pressure. The throttle valve used is of the quick-opening kind to develop peak horsepower almost instantaneously. Suitable speed reduction is obtained by single-step spur gearing between the motor and the drive shaft, which is keyed or splined to the Bendix or starting mechanism of the engine.

Clay crucibles possessing properties that make them especially suitable for smelting high-lead glazes and enamels have resulted from two recent developments at the National Bureau of Standards. One of these is a new composition that gives the body of the crucible an improved structure. The other, an added step in the lining procedure, aids in sealing invisible, incipient cracks. The usual clay crucible is porous and therefore subject to penetration and attack by highly corrosive melts. By contrast, the pores in the new one are very small and the interconnecting passages between them so minute that they effectively resist the flow of molten fluids.

Production Devices Incorporated has announced a new model in its line of Airlox vises. Designed primarily for use in connection with milling machines of 40 to 50 hp., the Airlox Senior exerts a jaw squeeze 200 times the applied air pressure. Thus an operating pressure of 100 psi. results in a grip of 10 tons per square inch on the work. The vise is designed so that air at 200 psi. can safely be applied if maximum gripping force is desired. It is 45 inches long, 13⅛ inches wide, 8¾ inches high, and weighs approximately 575 pounds. Jaws are 10½ inches wide, 3 inches deep, and have a maximum opening of 12 inches. The jaw stroke can be adjusted from a minimum of 1/16 inch to ⅝ inch.



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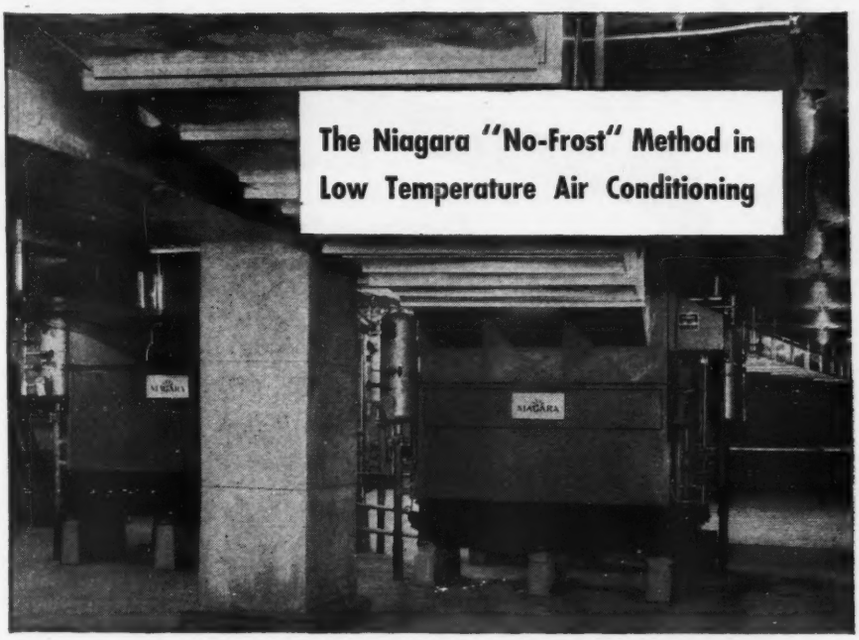

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Standard Micro-Klean models handle volumes up to 80 cfm of free air and pressures up to 125 psi. They have been adopted as standard equipment on such widely divergent applications as pneumatic mine-equipment, powder dispensing devices, motor coach auxiliary air systems, spray painting systems, air instruments, etc. For more information, attach coupon to your letterhead.

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Industrial Literature

Light-weight air hose for use with hand-held pneumatic tools is the subject of a folder issued by B. F. Goodrich Company, Akron, Ohio. The hose, which is made in five sizes ranging from ⅜ to ½ inch, is claimed to weigh half as much as the conventional type and to be extremely flexible. The folder describes the construction of the air hose and lists its advantages and applications.

Pyott Foundry & Machine Company, 328 North Sangamon Street, Chicago 7, Ill., will send upon request a catalogue containing the latest prices, descriptions, and specifications of its cast-iron pulleys made to meet any commercial requirement. Units up to 60 inches in diameter with face widths of 22 inches are machine molded, larger and unusual sizes being machine swept and cored or made from patterns.

A new catalogue of the Heise Bourdon Tube Company, Inc., discusses improvements in design and gauge movements which have increased the working range of its Bourdon tubes. The pressure gauges are made in three diameters—8½, 12, and 16 inches—and are individually calibrated from standard pressures in ranges from 0-15 to 0-10,000 psi. Accuracy is guaranteed to equal one part in 500 and is greater than in the case of tubes for pressures exceeding 10,000 psi. The gauges are available for use in various pressure media, including mercury. Copies of the booklet may be obtained from the company at Brook Road, Newtown, Conn.

Obtainable from Ingersoll-Rand Company is Contractors' Combination Catalogue, a 40-page publication listing and describing equipment built by it for the contracting, mining, and quarrying industries. Rock drills, Jackhamers, paving breakers, pile drivers, concrete vibrators, hoists, pumps, compressors, and reconditioning equipment for Jackbits and drill steel are covered, as well as accessory equipment necessary for their operation. Requests for Form 202 should be addressed to the company at 11 Broadway, New York 4, N. Y., or any of its branch offices.

Speed Packing Manual, which is issued by Sherman Paper Products Corporation for shippers of industrial products, recently underwent its sixth revision and is now ready for distribution. The current edition, illustrated with nearly 200 photographs and drawings, gives detailed instructions for packing a variety of things ranging from clothing and jewelry to automobile parts and prefabricated houses. A section on corrosion prevention, based on wartime packing experiences, is intended for manufacturers and shippers of highly finished metal products. Copies of the manual will be sent upon request to the company at Newton Upper Falls 64, Mass.

Electric Machinery Manufacturing Company, Minneapolis 13, Minn., has issued a series of bulletins describing and illustrating its induction and synchronous motors suitable for work such as driving boiler-feed pumps, pumps for oil pipe lines, refinery pumps, centrifugal blowers, compressors, and large tube mills. Heavy-duty, squirrel-cage induction motors are dealt with in Bulletins No. 1300-PRD-189 and No. 1300-PRD-190, the former covering motors with four or more poles in horsepower ratings of 100 and more and the latter listing 2-pole motors with ratings of 200 hp. and larger. No. 1200-PRD-175 describes low-speed synchronous motors up to 5000 hp. in size and No. 1100-PRD-181 high-speed synchronous motors of 30 to 5000 hp.